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Trench warfare

Joseph Shuter Smith

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TRENCH WARFARE

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b

TRENCH WARFARE

A MANUAL FOR OFFICERS AND MEN

BY

J. S. SMITH

SECOND LIEUTENANT WITH THE BRITISH EXPEDITIONARY FORCE

NEW YORK

E. P. DUTTON & CO.

681 FIFTH AVENUE

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TO

THE AMERICAN OFFICERS AND MEN

WHO SERVED AND

ARE SERVING THEIR COUNTRY

UNDER ALIEN FLAGS

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INTRODUCTION

It is a safe bet that when the German army started for Paris they had plans for use in the event of disaster. The disaster occurred, and a new type of warfare requiring the highest courage, skill and endurance was born. I say born because although trench warfare was known before, it died in birth compared to this war, for the amount of science, energy and variety of weapons used.

More earth has been removed by a combination of man, pick and shovel in making these trenches than was excavated to make the Panama Canal possible, and in less time.

It is my object in this book to give a faint idea and knowledge of the trenches, and to approximately explain the way warfare is carried on, and I offer the information contained herein as a basic foundation on which to use the further knowledge you will gain as an officer, and which, for obvious reasons, I will not and cannot give here.

The notes are all taken from different courses

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of instruction, and observations made during thirty-one months of service, fifteen of which was spent on the Belgian and French fronts, both as private and officer in the infantry service.

I do not lay down my information as expert and final by any means, but as trench warfare changes from day to day, improvements are made, old ideas discarded, new ones tried, it can be seen that nothing can be laid down as a cut and dried rule, but the principles of trench building, generally speaking, remain the same. This I have endeavored to give, along with a few other notes which will give an idea of the many and varied tasks that a second lieutenant must know before he is fit to take hold of men in a place such as the Western Front, where there is very seldom a chance to rectify mistakes, or to experiment more than once.

When the British and French armies started their retreat from Mons, as far as the British army was concerned they were hampered by their want of knowledge of trench warfare as used in the South African war. The men retired day by day, hardly staying in one place long enough to dig themselves in. At that time for digging a trench system, one valuable lesson was learned, and that was, that the hole

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such as they had been taught to make in just such circumstances as they were up against then was no good, as it offered them no protection from overhead shrapnel, and at the best of times made a very poor shelter. This hole used to be dug a little more than the width of a man and straight back his full length, he naturally throwing the dirt in front of him and thus making a little parapet.

When the battle of the Marne commenced and the British and the French drove forward, this valuable lesson and many others had been learned, so that when the armies had reached the limits of their endurance, instead of digging themselves in in the old style, a new system was used, greatly assisted by shell fire.

A round hole was dug by each man to fit his individual size and made to suit himself. Here he squatted and fought, if necessary, and got what rest was possible during that day, with the enemies' line at distances varying from 100 to 500 yards from him. During the night, these men when not fighting or bothered by counter-attacks, or trying to obtain rations, water and the many necessaries that a fighting man requires, deepened their shelters and joined them together by little narrow ditches. During the next day there might be bitter fighting, so it

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would be even possible that other troops would come up and relieve during the early dusk. The relieved troops would retire a short distance and dig themselves another row of little holes where they might act as supports in case the temporary front line gave. During that night the holes on the front line would be enlarged until they finally joined and gradually without deliberate intention the trench became a permanent feature. Then the line slightly in the rear became connected with the front line system by what were then nothing more or less than ditches and this was the birth of the present system which now stretches from the sea to Switzerland.

The trench systems now generally consist of three complete lines or systems of trenches, each system being self-supporting and independent of the other. The second and third systems are generally laid with due consideration to protection, fields of fire, and all the other tactical requirements that are necessary to such a system; it being impossible in the majority of cases to keep these points in mind during the building of the first or original line. These systems generally run to a depth of six to eight miles from the front firing line. They are so constructed that when a firing line has been

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broken through to any great extent, what was formerly a communication trench at once becomes a fire trench, and serves to bring a heavy enfilade fire on the troops occupying the captured area.

It must be remembered that the considerations, arguments, and notes laid down in this book cannot, under stress of circumstances, always be acted on. It will be found, however, that a certain amount of training and of study as to the conditions governing the sighting, building, and living in these trenches, will cause a man, even under great stress of excitement, to look for and try to obtain the ideal as a matter of habit and without giving much time and thought to the question.

The Art of War is "the greatest amount of common sense used in the shortest possible time."

J. S. S.

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EDITOR'S NOTE

Mr. J. S. Smith, the author of this book, is an American, born in Philadelphia, who enlisted in the 29th Vancouver Battalion in the fall of 1914. He saw service along the Belgian front, and in August 1916 was given a commission in the British Army. He is now (June, 1917) serving with the British Expeditionary Force on the French front.

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TRENCH WARFARE

LOCATION AND CONSTRUCTION OF TRENCHES

In locating the site for a defensive firing line, it must be divided into three sections:—firing line, immediate support and reserves. In doing this several opposing factors should be taken into consideration and their relative importance judged according to the special circumstances and objects in view, keeping in mind the probable lines and manner of defense of the enemy, and whether the trenches are for permanent or for temporary use.

This may be summarized under two heads: first, with the object of attaining the greatest field that can be covered by defensive fire; and, second, the greatest security from offensive fire.

It will even be found that these two constructions will be in conflict. Trenches placed behind the crest of a hill, say fifty to one hundred and fifty yards from the top, will hamper the accuracy of the enemy's artillery fire. Shoot-

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ing, to be effective, calls for a high rate of accuracy, and here the only observations possible are from aircraft and balloons; but the enemy side of the hill will be raised ground to the occupants of the trench. At night large numbers of the enemy could collect there, and the dangerous space to them would merely be the distance from your fire trench to the crest of the hill.

The enemy could and would entrench themselves on their side of the crest and by raising their parapet enjoy the advantage of a higher front, which would eventually lead to their entirely controlling the area behind your trenches, which are continually used by the relief and fatigue parties.

It is a principle that grazing rifle fire upon a defensive enemy is more effective than plunging fire, but any entrenched position higher than your own held by an enemy gives them a tremendous advantage. Regardless of what opinion may be held as to the maximum depth of a field of fire required to meet or repel attacks, whether in masse or open order, it should be obvious that the greater the depth of the field of fire and the more extensive the view of the enemy's operations, the better it will be for the defending forces.

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Protection from and localization of artillery fire must be provided by the internal construction of the trench rather than by a position that protects but also restricts the field of fire. There are frequently found in front of a firing line small areas of ground which are not covered by direct fire from your trench. A flanking fire frequently can cover these areas, but in spite of this, they must be watched constantly by means of listening posts or concealed observation posts, which may be hidden by the banks of rivers, hedges, ruined houses, or whatever natural existing concealment renders observation possible.

At night, it is a safe principle to support listening posts by automatic rifles, trip wires with noise making arrangements attached to them as common sense under the circumstances dictates. Great care and caution must always be taken to prevent the discovery of these listening posts by the enemy, and when discovered, alternative posts should be made or greater care taken for the protection of the men occupying these posts, such as overhead protection by mesh wire against bombing, and the upkeep of a small supply of bombs and close-range weapons in the post. The important trenches on the front having been located with a view

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of protecting the immediate front and with due regard to their relation, tactically, to the other trenches already located, the connecting trenches obviously must be subservient to the more important ones. Every endeavor must be made to avoid enfilade fires in the flanks, to give and to receive mutual support, and in particular to support those flanks which are not protected otherwise.

It is an essential consideration in the location of all these trenches that lateral communications can be established, and that supplies, supports, reserves, ammunition, etc., together with the means of retiring if necessary be taken into account. The distance from the water supplies and the possibility of concealing approaches is a further governing factor, although in many cases an ideal condition cannot be realized.

Then there is the counter attack, in case the fire trench should be taken, and the kind of soil which is so essential to its relation to bad weather and water seepage—these also require thought and study.

These things are main considerations to be kept in mind after a line has been settled on, whether during attack or whether siting trenches under common circumstances. It is not expected and is not necessary, when trying

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to obtain a position during attack, to keep all of these conditions in mind, but it is essential that when the attack has been finished and things return to slightly more normal circumstances, that these things be given instant consideration and proper action taken.

Were such a thing as concealment possible, it should be the first thing of importance to be kept in mind. Listening posts, machine gun positions, reserve dugouts, company, battalion and regimental headquarters, and similar things, at some distance behind or on fire lines, may be concealed, but fire-trenches are sure to be observed sooner or later (mostly sooner) by aeroplane and other means of observation, and it is best that one should admit the impracticability of concealment at once and take the proper protective measures. If opportunity for concealment offers itself, as it may do, according to the lay of the land, it should be taken always. It should always be kept in mind that one should try to place himself in the position of having the enemy's point of view, both from his trenches and his aerial observations.

Advantage should be taken and even care given along trenches to the extensive cultivation of the weeds, grasses, etc., that may grow rapidly in the excavated soil.

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It is, and always will be, a matter of much argument that trenches should not be dug near hedges, ditches, roads or rows of trees, on account of easy ranging mark given to the enemy artillery. In a country where such things are scarce, the idea may have a leg to stand on, but certainly to the Western Front it does not apply. It does not take artillery a moment to approximate by ranging shot, check by deduction or addition the range of trenches in any area, even if lying along a hedge or road. The ditch or hedge in some cases will provide the starting of a trench and offer fair amount of cover from fire to the troops working. A ditch immediately in front or behind the trench greatly helps to solve the many and varied difficulties of drainage, and when in front of a trench, can be made into a formidable obstacle, generally by throwing in varied lengths of barbed wire. Trenches under the cover of a hedge are very often safe from aerial observation, and even when located, sniping and observation can be carried on from them if the contours of the ground are favorable. It is always possible to do a certain amount of repairing and moving of troops only when unobserved from the enemy's trenches. If advantage is not taken of these natural protections,

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such as hedges and trees, then they must be destroyed.

It is obvious that a great deal of labor can be lost and work thrown away if a policy is not adopted and continued. Battalions relieving one another up and down the line may waste a tremendous amount of labor unless the relieved officer's policy is explained. If each commanding officer of a relieving battalion is permitted to air his own theories, duplication of work and lack of continuity will exist. Therefore, it is essential that the officers relieving the trench be thoroughly informed of work going on. With this object in view some of the officers of the relieving battalion should do a tour of duty (about 24 hours) before their troops take over the trench. An Officer and Non-Commissioned Officer are detailed from each relieving company for this duty. In the trench this officer is instructed by the senior officer present, and the non-commissioned officer by the ranking non-commissioned officer, in the policy to be continued. The commanding officer of the occupying company should have a sketch map of his sector of trench which he turns over to the relieving officer. This map should show the work under construction; proposed work; wire defenses; and if possible, the enemies ma-

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chine gun emplacements, observation posts, snipers and work in progress. The notes accompanying the map should give the general conditions concerning the work—depth to which it is safe to dig, nature of soil, conditions regarding drainage, and all information in regard to the enemies' activities during the period of occupancy. In addition, the relieving officer has the trench diary showing all the information covering every minute detail of the happenings during that company's stay in the trenches. This diary is a continuous record of that particular sector and remains with the occupying company until it is relieved and then passes into the possession of the relieving half company, and so on, forming a continuous running record of the policy applying to the upkeep and methods employed therein. This diary, unless it is buried to avoid falling into the hands of the enemy, will continue until the end of the war. So every half company inherits one from his predecessor in the line upon its assuming the obligations previously assumed by its forerunner, thus preventing a duplication of work and assuring continuity of endeavor.

There are certain obvious requirements that have to become rules. When required to fill sandbags, always look for the nearest excava-

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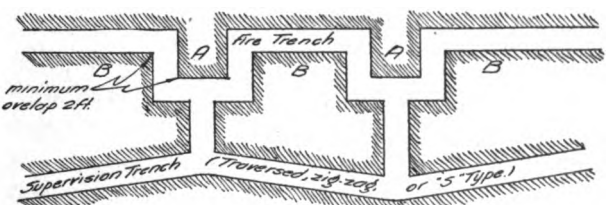
tion being made and fill from there, if distance permits.

As a matter of fact, in every trench there is a continuous revetting, widening of communications or control trenches, or driving of a tunnel to a listening post.



A- Parapet Traverse
B- Parados Traverse

TRAVERSED & RECESSED TRENCH.

Inasmuch as the time for filling sandbags is never ending, if work is being done and the earth is not absolutely needed for parapet or parados, the earth, if dry, should be put in sandbags, and, if necessary, stored until it is needed. The repair work that is most necessary takes precedent and is about as follows: Any damage to parados or traverses should be immediately attended to. During the night any damage to the wire entanglements must be repaired. Drainage comes next in order of im-

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portance, and this involves the digging of sumps and deepening of the drainage bottom. These are the repairs, but improvements must continually be made in the dugouts and communication trenches.

The ultimate design of a fire-trench depends upon its closeness to the enemy. When the latter are within 150 yards, the traversed fire-trench shown in sketch should be employed, as it provides adequate accommodation and protection for men who may at any moment be called upon to make use of bomb, bayonet and bullet; but if the enemy trenches are more than 150 yards distant, the ultimate design would depend upon the number of machine guns and automatic rifles available. Each of these guns has a firing capacity of about 25 rifles. Each gun therefore gives a reduction in the number of men required to hold the line, and in consequence reduces the amount of trench needed to protect these men.

A design, known as the "T" shaped fire-trench, makes an adaptable basis for entrenching under these conditions. Many lengths of a continuous traversed trench have no great field of fire, and yet, having been dug, they must be held, and unless properly held and kept in

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repair, they naturally become a source of danger.

As shown in the sketch, a traversed trench consists of a series of fire-bays interrupted by a series of traverses. The object of these being to localize the effect of shells or bombs landing in a fire-bay, and preventing enfilade fire down the length of the trench, as well as localizing any entry of the enemy into your line.

Dimensions vary up and down the line. Sometimes according to the lay of the land, sometimes according to the opinions, whims or fancies of the regiments making them, but the following dimensions should be kept in mind, and it will be found that they show the average of the whole general line on the Western Front.

Fire-bays generally are from 12 to 18 feet long (defendable by 4 to 6 men, but accommodating 8 to 12, when necessary) plus a 2-ft. covered sentry-box recessed into the traverse and giving room for one more man; this depending entirely on the energy and initiative of the men occupying the section.

Every traverse averages 9′ x 9′ which includes a fairly liberal allowance for wear and tear, and is the minimum allowance for stopping enfilade fire and localizing fire. As the width from front to rear varies, depending on

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the amount of shell fire, it should be wide enough to allow a certain amount of lateral traffic without interfering with those who may be firing. Three feet may be taken as the maximum width at the bottom of the trench, that is, 1½′ for traffic and 1½′ for those firing, with a slope to the sides of from 10 to 15 degrees from perpendicular, thus lessening the tendency of the walls, whether revetted or otherwise, to slide in.

The depth of the trenches varies also, for the same reasons that cause the width to vary. Recesses should also be dug at various and favorable places for the storing of ammunition and bombs.

When digging entrenchments without regard to concealment, the excavated soil is first of all thrown to the front or enemy's side of the trench, thus temporary cover is obtained. When the entrenchment has reached the proper depth the artificial raising of the ground is leveled. The artificially raised portion is known as the parapet. On the completion of the parapet, the soil is thrown to the rear side of the trench, thus forming the parados which gives a protection from the rear. It is not a good policy to excavate in front of the parapet, but to get additional height and thickness as quickly

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as possible this is often done. Unless carefully watched, men will dig this dirt from places as near the parapet as possible, resulting in the weakening or total undermining of the parapet or trench wall. The more gradual the forward slope of the parapet, the more does it approximate as it should to the glacis of a fort, consequently giving less cover to an attacking enemy. Make use of the ditch or holes from which the dirt was obtained, as a strong obstacle immediately in front of your trench, where the enemy at the last moment may be held up to go under a very severe rifle and bombing effort. In normal circumstances, by which I mean when not exposed to an unduly vigorous machine gun or artillery fire, the soil should not be taken from in front of the trench in the manner described above, closer than 10 to 15 feet from the actual parapet, unless the holes are adequately protected by trip wire, as well as barbed wire. Cases have occurred when valuable information has been obtained by the enemy lying in holes thus dug and not properly protected.

The parapet should be kept as low as possible and made to blend with its surroundings as much as possible. This is done by taking great care to cover any signs which show that fresh work has been done, even to the extent of ac-

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tually planting grasses, weeds and roots, such as grow in the immediate neighborhood, and giving every encouragement to those that already grow. This greatly hinders the enemy's artillery, as it changes positions up and down the line; interfering with and hindering the observations and accurate ranging by their forward observing officers, checking charts turned over by relieved batteries.

Bullet-proof nature of a parapet naturally depends on the soil of which it is composed. Although it is not necessary to memorize the minimum of safety, you should keep a general rule in your head. The parapet should not be less than five feet, regardless of the kind of soil. When the trench has been carefully sited for the actual field of fire from a ground level, this thickness is best obtained by raising the ground level artificially as little as possible and getting the necessary depth by digging, unless prevented by moisture.

Unnecessary casualties are caused by the practice of putting a single row of sand bags along the top of a parapet for temporary purposes of concealment, as it gives a faulty idea to the men in the trench as to the real height of the parapet.

The parados gives protection from the effect

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of shell fire bursting behind the trench, and should be made fire-proof as soon as possible, although it is not necessary unless concealment is possible to level it down in a similar manner to the parapet. As a matter of fact, it should be at least a foot higher than the parapet, thus providing a background for the parapet. It has been known to happen that when the occupants of a trench have been reached by the enemy they have vacated their trench and used the parados as a parapet, much to the surprise and disgust of the enemy. In a high and irregular parados, places could even be found which when not used steadily provide unexpected and safe observation and sniping posts, but care must be taken that they are not used too often.

If a trench were used merely for firing, 4½ feet from bottom of trench to top of parapet would be a sufficient depth. During attack, however, when fire from loopholes is too restricted, exposure of head and shoulders over the parapet becomes necessary, but it is not necessary to expose men moving along the trench and not actually firing. If the trench should be 7′ or 8′ deep, you must provide a platform at the bottom of the front wall 1¼′ wide and 4½′ from the top of the parapet. This is called a fire-step. The rest of the trench can

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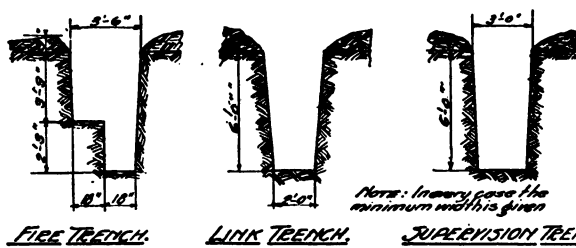
be deepened to any desired depth, depending on the energy displayed. If of an extraordinary depth, steps must be cut to the fire platform.

In a great many different parts of the Western Front, especially Belgium, it was found that after digging to a depth of one to three feet water was encountered to such an extent that it



became impossible to dig any sort of a trench which would give adequate protection to the men involved.

When these conditions are run into, breast work parapets must be artificially built up above ground level with soil, sods and sandbags, supported by sandbags, hurdles or close wire netting, revetment and stakes. The same principles of thickness, depth, width, slopes, and in fact everything that applies to a dug-in trench, applies to breast works.

The "T" trench has many more advantages

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than the few mentioned in the opening of this chapter. T fire-bays may be single, double or treble (that is with one, two or three bays). Fire-bays in any length up to 15 feet with 8 feet traverses are for firing purposes only, and the control trench, sometimes known as the lateral communication trench, as its name im-

S & T TRENCH.

plies, giving lateral communications, is used for that purpose only. Therefore, the fire-bays and control trenches can be narrower than trenches which have to be used for both purposes, thus lessening the amount of repair and revetment work required. And the intervening ground between these fire-bays gives the same result as a traverse used in a traversed trench system, and saves the labor of digging a more intricate system. The control trench gives an officer or N. C. O. in charge of the T bays a

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chance to handle his men and fire in these bays without struggling around innumerable traverses and wasting time very often when a minute lost or gained means lives lost, or part of a trench system in the hands of the enemy.

T bays may be sited with due and careful consideration while facing the enemy in an existing trench system. Thus it gives you the advantage of being able to take into consideration all the requirements of the field of fire, control of isolated areas, and the obtaining of maximum results from enfilade fire. These T trenches may be dug out from the old system without undue exposure of your men and if distance between the lines permits, and it is entirely possible to construct a new and generally more favorable line of trenches within 100 to 200 yards of the enemy's trenches. Intervening ground between these T bays must be completely controlled by entanglements and mobile machine guns, or automatic rifles, able to operate from different alternating recesses in the control trench. Fire platforms should be placed in recesses at intervals in the control trench from which covering fire can be given. Artillery fire to damage a T trench, must be very accurate. In a traversed trench a shell destroys not only lateral communication, but

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the defenders as well, whereas with a T shape, both fire-bays and control trench have to be ranged and hit. The success of the enemy is entirely local when capturing one of these T-bays, and he may be shelled by your own artillery without any danger or risks to those defending their T-bays. Control trenches should be dug first and zigzagged with the longer stretches facing the enemy. This gives you another fire-trench as well as a communication trench, and is also ready for use at any time needed before the T-bay is completed. On the completion of the T-bay, the corners of the zigzagged trench must be rounded off to make it easier and quicker for the movement of troops and carrying of stretchers.

DUGOUTS

It is only under very exceptional circumstances that under-cutting a trench wall is allowed, and then the shelter should be cut in the rear wall only. These shelters must be carefully supervised and watched by the officer, as men are very often careless, with the result that the shelters are dug in a hurry and poorly. Then it rains, the shelter falls in, and the men are no

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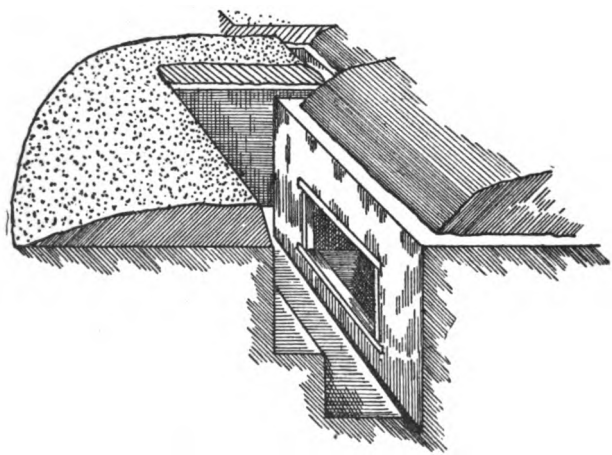
more. It should be high enough for a man to sit up straight, and long enough for him to lie down in, and deep enough for two men to lie side by side. It should be raised at least a foot



FIRE TRENCH, SHOWING ENTRANCE TO SHELTER
The shelter is of use only in a narrow or deep trench. Note that the floor is above the bottom of the trench.

above the floor level in the trench to prevent water from the trench floor coming in. A shelter smaller than these dimensions is useless. It has a demoralizing effect, destroying all activity, mental and physical. These shelters can

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only be properly made by cutting into the rear trench wall the necessary depth and length and right to the top. Then, with any material which is convenient, such as corrugated iron, brush wood, old rubber sheets, revet the sides and back. A corrugated iron roof is supported on posts at a depth of about a foot to a foot and a half below the normal level of the ground. Then, when possible, cover this with rubber sheets. If not possible to procure rubber sheets, simply cover with dirt excavated from shelter, taking care that it does not rise higher than your parados.

A fire-trench, however, is not a proper place for shelters, and they are generally better as a weather protection than a shell-proof shelter. Even this should not be favored too much, as it tends to cause obstruction, delay and inconvenience in the passing of troops. The real dug-outs for the accommodation of men holding a line are generally behind the fire-trenches in an immediate support line, or as in the case of T-bays, in the control trench and communication trenches leading to and from them. These are large dug-outs, having a depth of 30 and 40 feet, and in some cases capable of holding 100 to 250 men, generally having from 5 to 10 exits and entrances. Here the men stay during bom-

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bardments and are generally safe from any caliber shell which may light on top, unless a half dozen should light in the same particular spot.

This work is generally of a very skilled and technical kind. Plans, drawings and labor are supervised by the engineers, expert tunnelers being used in constructing work, although the infantry supplies working parties to dispose of the dirt, etc., resulting from these excavations and to carry the materials and tools needed and required in the construction.

The design and general scheme of a small dugout which can be made by the infantry under the supervision of an officer, without the aid of an engineer, are here given. The dugout should be approximately 6 feet from floor to roof and about 8 feet wide, with an approximate length of 12 feet, thus allowing men to lie down and yet leave room for passage through. The width depends upon the number you intend to have occupy it. Each man requires 18". Depth to be dug below ground depends entirely to what extent you may raise the roof upon the ground without making an unduly exposed hump which will at once tell the enemy a dugout is there. The thickness of the roof should be approximately 6 feet, constructed with side

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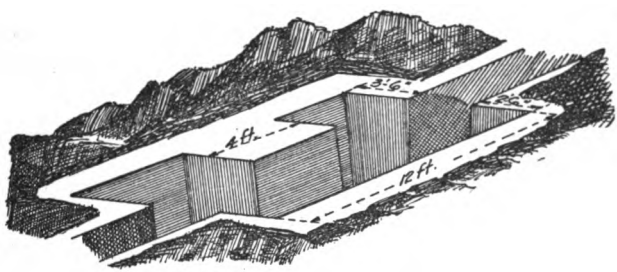
posts, cross beams, corrugated iron, water proof oilcloth, sandbags and soil. Sandbag revetments should be used in the strengthening of side posts. When possible, although hardly ever so, walls should be lined with waterproof



DUG-OUT WITH ROOF REMOVED.

Dimensions variable. Note the wide berms permitting the use of strong roof supports. A layer of large stones to cause early shell burst should form part of the roofing.

oilcloth and entrances so placed that they get as much sun as possible.

Great care and attention must be given to these dugouts, and even though taking a little longer than seems necessary, care must be taken to see that they are substantially constructed, otherwise they are in a constant source of danger of cave-ins during heavy shelling and bad

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weather. Not more than 10 men should occupy one of these dugouts. Then, if accidents happen, your casualties are not so great.

The roof of these dugouts should be prepared in a manner tending to withstand as high shell shock as possible, and for this purpose the following table would be of some use, any part of which, or a combination of all, will give some idea of what is required.

RESISTANCE OF ROOFING MATERIALS

(a) Shrapnel bullets—Stout planks suitably supported and covered with corrugated iron and 12″ of earth or 3″ of shingle.

(b) Ordinary guns of 3″ caliber—Strong timber supporting 4 ft. of earth with a top layer of heavy stones or broken bricks to cause early shell burst.

(c) Field howitzers (of less than 6″ caliber) —12″ logs, supporting 8 ft. of earth with top layer of heavy stones or broken brick and lightly covered over with some earth.

(d) "Jack Johnsons"—20 ft. of earth or 10 ft. of cement concrete, reënforced with steel and covered over with a covering of heavy stone or broken brick.

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It is very often the case that there is a line of trenches with very few dugouts. Those that exist are mainly occupied by first aid stations with a medical officer in charge, and officers' headquarters. When such is the case, very narrow, deep trenches, known as retirement trenches, are dug roughly from 20 to 50 yards behind the firing line, so that every one, except those on sentry duty, may retire there during the heavy shelling. It is very obvious that excellent communication must be kept up between this trench and the firing line.

DUMPS

Sandbags, corrugated iron, floor boards, ladders, pails, brushes, rubber boots, periscopes, barbed wire, etc., are what are known as "trench stores." These are generally brought up by carrying parties during the night and taken to some convenient spot picked out by whosoever may be commanding that particular section of trench, ready for distribution in the morning. This place is known as a "trench dump." Here every morning each junior officer goes to his company commander with a request for his stores for the day. When this has

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been handed in and approved by his company commander, he then has a party detailed to go and collect his stores. These are again placed in his particular little sector of the lines and he receipts for their care and proper use; all stores not used are turned over to the relieving troops and a receipt taken for same. These dumps must be made in a central location, both as regards the company dump and the platoon. The company dump is not a permanent home for the stores or utensils brought up, but is merely what might be called the distributing center. When a company commander turns over his trench stores and utensils to the relieving commander, the fact that he has all his stores and utensils in the company dump does not show merit, but merely inefficiency, that the distribution, which should have taken place, has not been carried out, and, therefore, that some of the men under his command probably have not the required tools to work with or the material that is necessary to the small units to carry on their daily lives. Stores should not remain in their center dumps. But each platoon commander should know exactly how much he has in hand, and how much he needs. It is also plainly evident that in a scattering of dumps in this manner, any captured by the enemy do not consti-

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tute a "knock out" as far as the trench stores are concerned.

LATRINES

The cleanliness of the trenches and latrines requires the closest supervision of all officers and non-commissioned officers. The bucket system of latrines is entirely unsatisfactory. The ground where the buckets are in use becomes unsanitary, and so does the ground in which the contents are buried. Double labor and carriage is involved, and as often as not a polluted soil is sooner or later to be found in the line of a proposed communication trench. The method used in the French armies is very good and by far the cleanest. It involves no unpleasant labor and is satisfactory. A pit about 12 feet deep, 3 feet wide and 12 feet long is dug in some place which is fairly easy to get at by those who are to use it. Generally thirty to forty feet behind the fire-trenches and off one of the communication trenches. The pit is boarded over, the boards being laid across the width, that is from front to rear; every other board space being omitted. A pail of disinfectant is kept standing nearby, and the deeper the pit is, the better and longer it will remain in use,

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but should be filled in when contents are within 6 feet of the top. This makes subsequent unpleasantness very unlikely. Care must be taken that men using these places have some protection from stray shells, and are out of sight of the enemy.

When possible, there should be a refuse pail for every section of men, and care should be taken to impress on the men that they must throw in all tea leaves, dregs, all scraps of food, and refuse in general, and should be covered over with disinfectant. If this is not done, thousands of flies and insects are attracted, with the inevitable rats, and disease and unsanitary conditions will follow. Tin cans, etc., should under no circumstances be thrown over the parapets as the same results will occur there.

REVETMENTS

When fire trenches are to be occupied for any length of time it is necessary to revet them. By that I mean the walls, and especially front walls, have to be faced or strengthened by sand bags, boards, corrugated iron or other material that is needed. This work to be of any use at all must have solid foundations and be thor-

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ough from top to bottom. Careless revetment work is of no use and a source of endless labor and trouble. All such work should be supervised by officers or N. C. O.'s who have a thorough understanding of such things, and they will be amply repaid if they take an active part in the work with their own hands. There are several forms of revetment, according to the materials available and the conditions of the walls to be revetted, but the usual materials are the sandbags, corrugated iron, stakes, boards, wire netting, etc., and these can be used either separately or in a combination. All these materials are generally kept in engineer dumps, some little way behind the firing line. Requisitions are made during the day by the officer commanding the sector of trench which requires revetting, and at night the men are detailed in carrying parties to go down to the engineer dumps and carry these things up for work the next day.

Sandbags. Sandbags are usually available in large quantities, but it is well to remember that generally only half the number indented for reach the indentor. The rest generally go around the men's feet and legs to keep them warm at night, and very often are used as a sort of mattress in the dugouts. This

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should not be allowed as it creates a tremendous wastage. The sandbags should only be about three-quarters filled, thus allowing for the choke or neck end, after tied, being turned under the back when laid in position. This also gives something to catch hold of when laying and brings the weight to something manageable, about sixty pounds. A bag three-quarters filled measures approximately 20″ x 10″ x 5″. Laid sand bags are called headers, when laid with bottom of the bag facing the center of the trench, and stretchers, if laid with the side facing the trench as per sketch. The neck end should always be tucked well in the bag in the case of the stretcher; the side seam, which is a weak spot in the sand bag, should be kept from exposure, that is, should be turned from the center of the trench.

When the front wall of a trench is to be revetted and only sandbags are available, the wall should first be cut to a slope of from 10 to 15 degrees from the perpendicular, and the loose soil obtained, if dry, placed in the sandbags. When there is an unrevetted fire platform, this should be also cut away and put, if dry, in the sand bags. A bed should then be dug about 6 inches into the solid bottom of the trench (disregarding the soft mud which for

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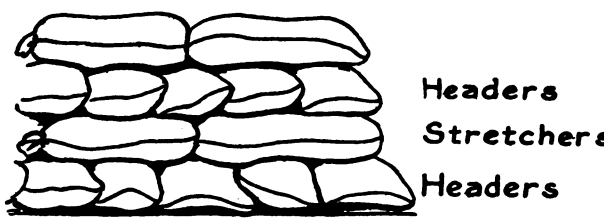
foundation purposes is of no use) and sloping down into the parapet at right angles to the slope of the front wall. Into this bed place a row of headers. On this row place a double row of stretchers. Joints must always be the same manner as brick-laying; that is, care taken that the joint where the ends of the stretchers



meet does not come immediately over the joint between the headers and the lower row. Sand bags should now be beaten down flat, generally with a wooden mallet provided for this purpose; then alternate rows of headers and stretchers laid; each layer being flattened out with the mallet until the top of the parapet is reached. The top layer should always come out as headers.

Twenty-five headers or twelve stretchers, or sixteen mixed, is the average required for revetting every superficial yard of trench.

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The slope of a front trench wall, even when from 10 to 15 degrees from perpendicular, is apt gradually to assume the perpendicular, and then fall in, owing to the sinking of the trench bottom or the actual thrust of the earth in front. This can, however, be checked by using 6′ to 8′ stakes driven well into the front wall foundation, and at the same angle as the front wall. Then, wiring the head of these stakes to what is known as an anchor-stake driven about 10′ into the ground in front of the trench.

Sandbags come in bales of 250, which are again divided into bundles of 50 each. On a carrying party it is an average rule that each man carry 100 sand bags.

Corrugated Iron. Generally, when lengths of corrugated iron and plenty of floor boards and stakes are available, this material is used for revetting the lower half of a trench wall, as it removes a great many difficulties, such as looking over substantial foundations for sandbag revetments. It makes it unnecessary to fill sandbags, etc., thus saving a great amount of time and labor. In revetting with corrugated iron and stakes or hurdles, cut the slope or wall from 10 to 15 degrees from the perpendicular, putting the soil in the sandbags and leaving it in some handy place for any future use. Then,

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drive 6′ to 8′ stakes well into the trench foundation and approximately 4′ apart, thus giving adequate protection to each piece of corrugated, having the stakes at an angle of 15 degrees at least, from the perpendicular, and 6″ or 8″ away from the trench wall. Then, slide the corrugated, hurdles, or boards on their sides down behind the stakes, overlapping slightly the ends and ramming them well down into the mud or soil in the bottom, and filling in the space behind with soil.

The bottom third or half of the front wall is thus substantially, easily and quickly revetted, and the upper half or remainder is generally revetted with the sandbags, a bed being dug so that the first layer of headers is about half its depth below the top of the corrugated. If stakes shorter than 6′ or 8′ have been used in the revetting, half should be cut off to where the sandbag revetting commences and wired to anchor stakes, driven into the parapet end of the bed, and not wired over the top of the parapet, as it tends to gradually pull them upwards. Then cover this wiring with your first layer of headers. When hurdles or floorboards are used instead of corrugated iron, empty sandbags or similar material must be hung behind them to prevent the soil crumbling through and thus

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weakening the foundation of the sandbag revetments. Corrugated should not be used for revetting the front wall higher than 2′, which is the width of one sheet, as the supply is generally limited and can be put to more valuable use as dealt with later.

Corrugated iron comes in bundles of about 24 sheets to the bundle, averaging 6′ by 3′. Two sheets is the average load for any one man in a carrying party.

A front wall constructed in the manner shown, if prompt and immediate attention always be given to repair if damage is done, will give very little bother. It is the usual custom to construct your fire platform after this revetting work has been done.

A trench should be dug no deeper than will afford protection to the firer, a deeper passageway necessitating a fire platform, a subsequent work, and by first revetting the whole front wall from bottom to top then adding the fire platform, each gets the benefit of the foundation of the other. Until this fire platform is constructed, emergency methods may be used and improvised in a moment with ammunition boxes, loose sandbags and the various other junk which accumulates in a trench.

Fire Platforms. Now that the front wall

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has been revetted, either with corrugated or sandbags, the construction of the fire platform should be at once started. To start this, short stakes should be driven well into the trench bottom about 36″ from the front wall and parallel to the slope of the front wall, averaging from 2′ to 3′ apart and generally as substantial as the large revetment stakes, although this is not of absolute necessity.

When brushwood is procurable, it should be used as a foundation, putting it in after the short stakes are driven and ramming it down behind them. This gives you as nearly as possible a dry and compact foundation for your first row of headers. Then this may be covered with another lot of brushwood, and that again by a row of headers, and from then the layer should be alternate headers and stretchers. Sand bags do not offer a good platform after a heavy rain, as they become wet and slippery and the material quickly rots, then they break open and the top of your fire platform is gone. To avoid this, it is necessary to use whatever material may be at hand in the covering of the top layer.

One good way of providing this top covering when the material is procurable, is a wire netting used in a double thickness. It should be

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placed behind and up against the stakes before the foundation is laid. Then when the fire platform is built to its proper height, bend the wire from the top of the fire platform and fasten it down on the sides by whatever means are handy. Using this double wire netting makes it possible to use brick and all sorts of general trash in the construction of the fire platform and gives a very good dry footing. When doing that the face of your platform should be either corrugated sheets or boards.

Very often what are known as sentry-boards, or small floor boards about 36″ square and with additional cross pieces underneath, giving them a height of about a foot, thus raising them well out of the mud, are used, and are very handy before a fire platform is made, and in some cases have to be used for small men after the fire platform is made.

TRAVERSES

All the walls of the traverses must also be revetted, generally with the sandbags and in exactly the same manner as the front walls of a fire-bay, care being taken to keep it well sloped. This leads to a lessening of protection afforded

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the occupants by making a greater width at the top of the trench, but it is absolutely necessary unless you wish your whole traverse to gradually fall in, when you are in a position of having no protection at all. The top of the traverse may be and is often several feet higher than the parapet, if the fire-bay it protects is exposed to enfilade fire from the enemy trench at a higher level. But when this is not the case, the traverse should not be higher than the parapet or parados, and should slope down towards the enemy to give the appearance of being merely a continuation of the parapet.

The traverse should never be less than 9′ wide, allowing 2′ for a sentry box, although this sentry box is no longer generally in use.

What are known as overhead traverses are made generally in a communication trench leading up to the front line, and which in certain parts the enemy are able to look into. These overhead traverses give to this particular place the protection which is necessary. They are quickly and easily made by placing corrugated iron, logs or strong branches, or floor boards, across the top of the trench and putting sand bags on the top of these. When the trench walls are weak, or even on general principles, the

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sides supporting this overhead traverse should be revetted with sandbags.

The sentry boxes, although not in general use now, are described, more for general information than anything else. They are dug or recessed in the traverse at either end of the fire-bay and must have an observation slit in the parapet for use by day, but no loop-hole facing the enemy, as regardless of the care and caution used in the construction of these loop-holes, they will sooner or later, generally sooner, be observed by the enemy and the sentry box made useless.

During an attack this sentry box is never used, except for stores or the placing of wounded, as there will always be plenty of room for the late occupant in the fire-bay itself. Sometimes, when energy and time permit, an enfilade fire loop-hole is made through the traverse and facing the next fire-bay, but this has as much value for making easy verbal communication from one fire-bay to another as it has to the checking of attacking forces.

LISTENING POSTS

As before mentioned, in the space between the front lines of the opposing armies, which is

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known as No Man's Land, there are sometimes large and sometimes small areas of ground, ditches, streams, etc., which cannot be satisfactorily watched from a fire trench immediately facing them, owing to the lay of the land, hedges, old excavations, buildings, etc. This is the case in a great many instances regardless of the careful thought and the amount of time spent in siting a fire-trench, as the siting of all trenches is largely subsidized by the tactical position of the flank trenches. Very often a line of trenches is taken up under stress of circumstances that do not permit of the obeying of the rules and standards set for an ideal fire-trench.

The control of these areas is essential to prevent small surprise attacks, cutting-out parties and raids. During the day they are very often observable from a flank trench or higher observation ground in the rear, but at night this is not possible; so that listening or observation posts are gradually sited in front of the fire trench with due consideration to the situation in that immediate vicinity. A ruined shed, shack, cart, or any other thing of a similar character lying in No Man's Land is very useful for these purposes if it can be reached before the enemy reach it with the same purpose in mind.

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This cannot be used very long, as its purpose is too obvious and peace and quietness will not last long, but it will do until a more satisfactory arrangement can be made.

The listening post is often dug just inside the outer fringe of your own barbed wire entanglements, and is just large enough to allow two men to stand in unobserved. It should be reached by a very narrow, irregular trench running out from a fire-bay, where it is fairly easy to secure the maximum amount of concealment necessary to give protection. The soil excavated from these places must not be thrown out, but placed in sand bags and taken into the trench and used there. It is always best and requires very little more labor, and gives the maximum amount of protection to your listening post if communication to it be made through a tunnel.

These things are bound to be discovered within a certain amount of time, and when you know the position of your listening post has been found by the enemy, which you will know very quickly, owing to the amount of bombs and rifle fire it will receive for one or two nights, until you can dig another one, it is a safe thing to build up a small parapet, taking it down every morning before dawn. It then be-

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comes necessary to dig a new post, and this can be generally done by leading off from your old communication trench to some more favorable spot. When the new post is ready for occupancy, the old one should be filled in with barbed wire, or completely filled in again with dirt, and the sandbag parapet left to mislead as long as possible.

The first duty of a listening post is to listen and report. Most of the work is done at night, and no firing or sniping must be allowed from it during the day. Patrols generally come out via one listening post and return by another, so that all listening posts must be warned of the trench by which the patrol will come out and the approximate hour of departure and return. Patrols should never be sent out without definite orders as to what is required, and especially as to the listening post they leave and return by. Listening posts should fire without challenge at any one who approaches within sight, whether friend or enemy, unless it has been warned that a friendly patrol is out, in which event signals should be pre-arranged. Then the listening post will use the greatest caution and should challenge audibly when the patrol is close, and unless immediately satisfied, fire. Listening posts are connected with the fire trench by a

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cord or wire, and a simple code of tugs is arranged, or a bell fastened to the fire trench end for alarm in case of emergency, and here a sentry always stands to get any signals that may come from the listening post.

If a listening post has not been warned that a friendly patrol is out and fires on it without challenge, the L. P. is absolved from all blame.

When a hedge or ditch, which might easily provide cover to the enemy, is running parallel with the firing trench, it must be controlled at night by a machine or Lewis gun which is able to enfilade a frontal advance over open ground leading to it. If, as is often the case, the parallel hedge or ditch is easily approached along either hedges or ditches running at right angles to it, these angles must be protected by machine or Lewis gun firing down them.

When hedges or ditches running at right angles from the firing line and leading towards the enemy are in a sector of line, they should be protected from dusk to dawn by one or two men, generally only armed with bombs to protect against surprise, and great care must be taken that no more signs than possible are left to the occupancy of this position over night.

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OBSERVATION POSTS

Loopholes for Firing. During an attack, firing is never possible through loopholes as it is too restricted to be of any value. All the firing then is done over the parapet. The difficulty of constructing new observation posts which are effectual and inconspicuous for any length of time has resulted in their not being made in a parapet, where, when located by the enemy, they are as often as not a source of danger. Moreover, promiscuous firing through loopholes by inefficient riflemen is of no value. Sniping is under the control and supervision of a sniping officer, and loopholes should only be used by men appointed by that officer. They are not used at night and should be only used during the day for enfilade fire, and be placed in the parapet as low down as is consistent with line of site. A piece of cloth or empty sandbag should be hung from the rear of the loophole, so that when the hole is not obstructed by the fire, no light can show through. No shots should be fired from those loopholes, except at a definite target, and ranges of targets or spots where targets may possibly appear, should be ascertained in advance, and necessary exposed move-

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ment, such as withdrawal of rifle, must be very slow and gradual. With care, and when only used by a skilled rifleman, a loophole will be of value for probably two weeks and good results obtained, but by a careless man the value of a loophole will not last a day and very likely result in casualties not only to the man shooting, but to others as well.

In the area from 20 to 100 yards behind the fire trench, there sometimes is, although very seldom, ground much higher than the actual fire trench, so that it is safe to allow even hastily trained men to use it for firing over the heads of the main front line trench, although it has happened that men in such a position have fired into their front line, thinking it the enemy line. This ground is generally used by building what are known as covering fire trenches. These to be of any value, should not be more than 20 yards behind the front line, as farther forward than 20 yards they become affected by artillery fire directed at the fire trenches; and farther back than 100 yards the covering fire, unless in the hands of very skilled and efficient riflemen, becomes very dangerous to the men in the front line.

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SUPPORT TRENCHES AND SUPPORT DUGOUTS

A support trench is usually within 30 to 300 yards of a fire trench, and may serve the purposes of covering fire, trenches by skilled riflemen or an indirect machine gun fire, but their main purpose is to shelter troops from observation and shell fire, and thus their main characteristics become the size and strength of ample dugouts. Troops in the support dugouts are at hand for three purposes: Firstly, replacing of casualties occurring in the fire trenches during normal times or a hostile attack. Secondly, holding the support trenches in case the fire trenches are taken by the enemy. Thirdly, in the event of an attack on the enemy's trenches, leading the attack by moving forward over the heads of the occupants of the fire trench, or if the latter are leading the attack, to occupy at once the fire trench when vacated. For this reason it is of vast importance that there are accessible and commodious support dugouts and communications between the immediate support trenches and front line. If this is so there will be less chance of disasters to supports and reserves coming up

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to make good a successful attack. There must be support dugouts even in the event of there being no support trenches, and this is very often possible owing to the lay of the land. The strength and size of these dugouts entirely depend on tactical considerations and local conditions, which are generally decided by the staff.

SUPPORT POINTS

These forts or strong points, as they are sometimes called, usually round or square, but which may be any shape best suited to the condition of the country in which they are placed, are generally from 100 to 300 yards behind the fire-trenches and supplementary to the support trenches. Each of these strong points contains a permanent garrison of firing troops, strongly protected with barbed wiring and sandbag revetments, and well supplied with ammunition, food and water, to enable them to withstand heavy attacks. During an attack they are used to give overhead covering fire, and for the control of ammunition and other supplies to be sent on to the firing line. It is a general rule that if the enemy take a fire line the garrison of these supporting points must hold out and

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remain a thorn in the enemy's side until the last man of the garrison is killed.

RESERVE DUGOUTS

These dugouts protect the local reserves from which supports are supplied and are used for purposes similar to those for which the immediate support dugouts are employed, but on a great deal larger scale. These dugouts are generally near battalion headquarters and from 500 to 1,500 yards behind the firing line. The chief considerations in siting the positions of these dugouts are three: First: facilities for rapid and easy transit to the support and fire-trenches; second: concealment; third: comfort. Comfort should be secondary to the other conditions affecting the siting of the system.

SECOND LINE

This comprises the line of fire-trenches, with covering fire-trenches, support trenches, support dugouts and reserve dugouts (in other words, it is an exact duplication of the front line system), far enough behind the front line

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that in the event of the first system being taken, the second line is ready to be taken up by the troops driven out of the front line, and receive the support of troops lying in brigade or divisional reserve. The distance of the second line behind the first is roughly a mile, and while the first line is held, operations of the second often provide useful accommodation for the machine guns and artillery, both for firing purposes, observation and shelter.

The time available for siting and constructing second line system, and the freedom from all disturbances which bother the front line system, should result in its being impregnable. It is an ideal system provided those responsible for its siting and construction are thoroughly and practically experienced with first line conditions and profit by that experience and former mistakes.

COMMUNICATION TRENCHES

When siting communication trenches, two considerations come into conflict with one another; the desire for protection, and the necessity of rapid and easy transit. It is obvious that a C. T. is of vital importance to the firing

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line in the getting up of supporting troops, ammunition and stores rapidly and without undue fatigue. It is also obvious that it must give as much protection as possible to the troops using the C. T., but it must be recognized that the protection given must not interfere with rapid transit by making the C. T. too narrow. It must also be kept in mind that rapid transit in itself gives a certain amount of protection for the simple reason that the easier and quicker the transit, the less time are troops delayed in the C. T.'s in which protection is required, and if troops can cover the danger area in 10 minutes, they are plainly in danger for a less period than if it took 30 minutes to struggle over that same area. This rapid transit, only obtained by a dangerously wide communication trench from support or reserve lines and from dug-outs, also makes it possible for less troops to be regularly on duty in the fire-trenches, which are always uncomfortable and dangerous, especially during a bombardment, and it also enables supports and reserves to be rushed up quickly when the occasion demands.

It can be plainly seen now that a compromise must be effected between claims of protection and rapid transit, so that the size and shape of the C. T.'s will vary according to their distance

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from a danger area. Generally speaking, the nearer to danger, the more must the claims of rapid transit give way to those of protection.

Disregarding for the time being the claims of protection and only considering rapid transit, there are these things to be considered: First, that a C. T. be as short as possible, making use of contours, sunken roads and other natural features to avoid digging as much as possible. Second, that a C. T. be as straight as possible, which not only shortens the distance but avoids turns and corners which interfere with speed and which require renewed effort at every turn. These sharp corners and turns must always be avoided. This can be done without weakening a trench or increasing the risk, and every effort should be made to save troops carrying full equipment, stores, ammunition, or rations from unnecessary tiring, hindrances, and difficulties, such as sharp corners and turns. Third, the C. T. J.'s must be as level as possible, as they are generally slippery, and inclines or declines should be avoided as they very often cause accidents. A longer C. T. following around natural contours is frequently more advantageous for this reason than a straight one over a hill, which it is only possible to make level by an amount of digging out of proportion

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to the result gained. The C. T. must be wide enough for requirements. These differ according (a) to the proximity of C. T. to the fire-trenches, (b) to the number of C. T.'s available, and (c) to the use for which a C. T. is required, i. e., whether a double C. T. (for both up and down traffic) or a single C. T. (for traffic in one direction only).

When a C. T. is close to the fire-trench, troops moving into it are practically themselves in the fire-trench and as each group has probably to get to a different part of that fire-trench, all necessary traffic up and down the fire-trench and disturbance of the men occupying it must be avoided. Rapid transit can advantageously be obtained by other means than the width of the C. T.; by dividing the single C. T. at some point from 30 to 60 yards in rear of the actual fire-trench into a number of small narrow C. T.'s, each leading to a group of 3 to 6 fire-bays, and these may again be divided into those for up and those for down traffic.

This system requires a fair amount of thinking out and all the trenches should be plainly marked and named. These names are placed on notice boards at the different junctions having the proper indications and rules directing the use of up and down traffic. This is and

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should be rigidly enforced during both quiet and active periods, but takes on a much greater importance during active periods.

The width of these single C. T.'s running close to the fire-trenches should be enough to allow a man carrying full equipment, stores, or rations to pass along easily and without bumping the sides with his equipment or burden; approximately two feet at the bottom with ample room at all corners. The width of a single C. T. for down traffic only should be wide enough to allow for passage of a laden stretcher, especially at the corners, as a stretcher is a very clumsy thing to get around these corners and often the delay caused has very serious consequences.

As a C. T. leaving a fire-trench gets farther away, the width should be as soon as possible such as will allow two men to pass one another fully equipped without jostling or scraping the sides of the trench, or approximately 4 ft. at the bottom. This width with recesses described later allows rapid transit for troops passing each other in quiet parties and allowing a much greater safety in an emergency when there is no down traffic.

The front is always referred to as "up."

Another advantage to be gained in the width

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of the C. T. is in the fact that it is much easier to keep dry and usable. It permits laying of regulation floor boards, allowing enough room on each side of them for the purpose of drainage, and is a means of preventing falling soil from covering the floor boards. Water will not drain off or through soil which is continually trampled on and has become sodden or irregular, and unless the floor boards are kept free from soil, they soon become useless, crooked and immovable. The width of these trenches allows the wind and sun to reach the bottom of the trench, thus helping a great deal in keeping it dry. There is no such thing as a communication trench 18 inches wide at the bottom and 24 inches wide at the top; diggings of these dimensions are nothing more than drains which in an emergency only are struggled through when passing in the open is still more impossible, and they should not be given any consideration whatever as a C. T.

The features required in a communication trench, regardless of the claims of rapid transit and only considering protection, are:

(First) Frequent traverses or turnings to avoid the effect of enfilade fire, to localize the effect of a bursting shell or bomb, to make difficult a hostile advance down the C. T. and to

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enable bomb parties to resist more easily their advance.

(Second) A trench that is sufficiently narrow will localize the effect of a bursting shell or bomb and minimize the effectiveness of hostile fire, which must have a high degree of accuracy to be effective. But the quicker over the ground the shorter the period of danger, and shell fire of any degree of accuracy will substantially narrow one of these narrower trenches, damaging the walls and causing casualties and other obstructions which will render passage impossible with either one or two results. Delay caused at a critical moment, or the occupants trying to obtain a passage up the trench in order to take any part in the fighting, would have to come out into the open sooner than necessary. The shelling of the C. T.'s usually is heavier for perfectly obvious reasons during an attack and when rapid transit through them is of the utmost importance. A narrow trench generally takes as long to dig as one of the wider type, owing to the restricted area in which to work.

(Third) If invisibility be possible, it is an excellent feature, but in nine hundred and ninety-nine cases out of a thousand it is hardly possible. An observed C. T. indicates the posi-

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tion and direction of supports, stores, reserves, dugouts, etc. This fault can be corrected to a certain extent by the careful use of the contours, dead ground, sunken roads, and all natural features, such as woods and hedges. Artificial cover may and does assist concealment, but sooner or later hostile aerial observation and photographs disclose the position of more easily concealed things than an excavated C. T. It is frequently the shadow at the bottom of a trench which gives its position away to aircraft, and the narrower the trench, the more prominent is the shadow. The soil, which is generally a different color from the surface soil, must be thrown up on either side as time does not allow it being carried away. Unless in a place of artificial cover through the length of the C. T., it is usually necessary to admit the impossibility of concealment and utilize time more profitably by taking protective measures.

Rapid transit to a fire-trench is of greater importance than rapid transit from a fire-trench, and the importance of protection is greater as the fire-trench and its dangers are approached. Methods of construction should be based on this idea and the arguments given above.

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SKETCH OF TRENCH SYSTEM

This sketch shows a double-traffic communication trench leading (5 ft. wide) from reserves and H. Q. to a loopholed island-traverse about 30 yards behind the support line. At this island-traverse, single-traffic C. T. branches off to various sectors of the support line; the main C. T. leading on (from 3 to 4 feet wide) uninterrupted through the support line to loopholed island-traverse "E," about 30 yards behind the firing line. At this island-traverse the main C. T. breaks off into single-traffic C. T. 3 feet wide. Each leads to various sectors of the firing line.

Section I. C. T. should start behind one of the fire-trench traverses and not from a fire-bay. Every yard should be contestable for approximately the first 15 to 20 yards. This can be effected, and at the same time the effect of hostile artillery and rifle fire and bombs localized, by a series of traverses 9 feet square, the trench being approximately 7 feet deep and 2 feet wide at the bottom. Cut into the rear of a few of these traverses is a narrow recess through which one of the defending bombing party may take up a position in the

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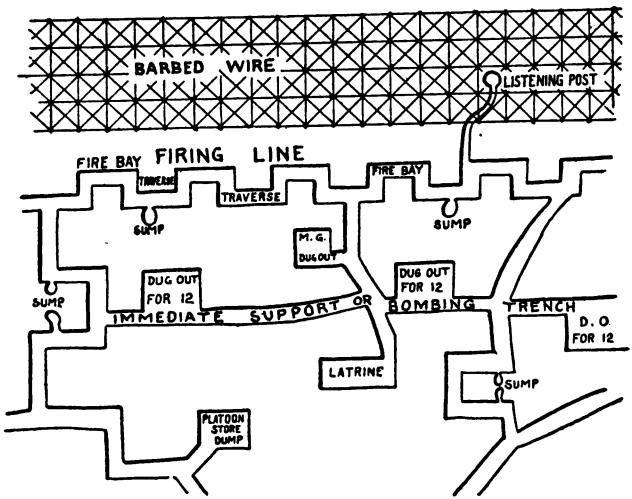

SECTION I
SKETCH OF TRENCH SYSTEM

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center of the traverse and fire, kneeling or standing, through a loophole at the advancing enemy. The recess gives him ample protection, including head cover, and is so cut that the entrance is out of alignment with the trench behind him and he will be unaffected by a bomb exploding there. At the same time he may work with, and direct, the bombers behind him who are bombing over the traverse, and if it becomes necessary, they can also take cover in the entrance to the recess. The loophole should not be placed so high that it becomes possible for the enemy to come forward under it.

The most dutiable arms for the members of the defending bombing party detailed for this traverse work are what are known as "close-contact weapons," generally including revolvers, bombs, trench knives, and very often a bayonet carried by pushing it down in the puttee.

Section II. The time and claims of rapid transit will not allow the traverse system as employed in Section I to be continued, the narrow single-traffic C. T.'s, from wear and tear and shell fire, soon become wider, and as the width would allow rapid transit to friend and foe alike, it is of the utmost importance that some means be adopted to deprive the enemy of this

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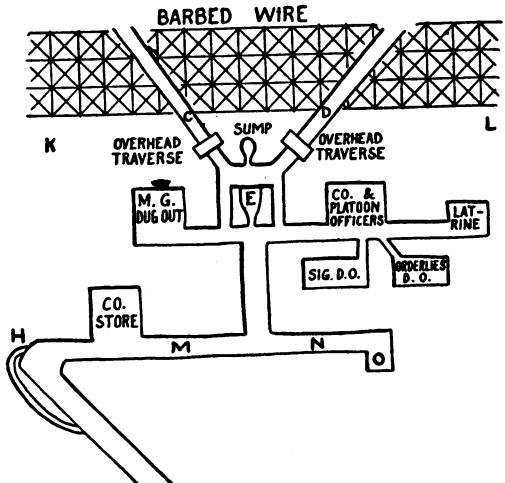

SECTION II

SKETCH OF TRENCH SYSTEM

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advantage. Moreover, the enemy may have successfully advanced down on traversed C. T., say, at "C," and our own bombers might still be fighting in another traversed C. T., say, at "D," and their needs demand protection. This may be obtained if, before the single C. T.'s merge into the double, each of them be quite straight for approximately 15 yards, and island-traverse, "E," be placed at the junction. In the rear of this island, "E," is a large and substantial recess, into which one or two Lewis guns or automatic rifles can be placed, firing through loopholes and rendering hostile advance down both "C" and "D" communication trenches almost impossible. The recess in "E" must allow ample room in which to operate. Overhead cover is provided, and one rifle would require one long loophole, so that it could fire along either C. T. without more than a moment's interruption. In the case of two rifles being available, there could be two such long loopholes, each covering both C. T.'s, one for kneeling and one for standing. The lower loophole gives the advantage of it being impossible for any of the enemy to get out of danger beneath it. The fact that the traverse is an island one, with passageway either side, would allow friends to advance round the traverse and up

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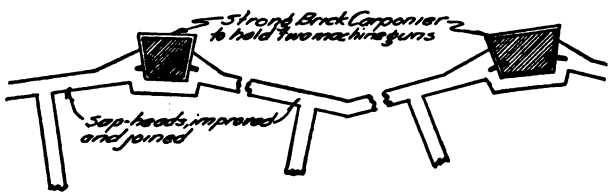
"D" to the support of friends still fighting there, and without obstructing the fire directed from the traverse at enemy advancing down "C."

An island-traverse so constructed and manned should be unapproachable along either trench "C" or "D," but precautions must be



ISLAND TRAVERSE.

A type used to control long, straight stretches of trench.

taken to prevent the enemy avoiding it by coming out into the open, as in active moments C. T.'s become as mutilated as fire trenches and the enemy may leave the C. T. before reaching the 15-yard stretch and approach the traverse from above or flank. In anticipation of this, the position "H" is selected slightly in rear and to flank of the traverse, and in this position one of the automatic rifles may take up, either originally or by retirement from "E," and deliver the required traversing covering fire across the

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front of "E" and giving adequate protection to the garrison manning the island-traverse. Barbed wire is also generally placed in open ground such as this described, say, for instance, between "K" or "L" on either side of the 15-yard stretches to impede hostile exit and advance. The overhead traverse just in front of the island gives protection against bombs thrown down on C. T.

When covering fire is not required, the position "H" will form an alternative position should the island-traverse be destroyed by shell fire or taken by the enemy; but the latter will be of little use to the enemy as their progress passed it is blocked by a loophole placed at "H" and covering the trench "M" down which they must advance. It also covers a dummy trench, shown as "N," down which there is a fair chance that the enemy would naturally go if a misleading notice were placed at the junction of "M" and "N." The slight turn at the end, "O," will prevent premature knowledge as to the real nature of this trench. The enemy's progress may also be blocked for a short time by having rolls of looped wire, sometimes known as concertina wire, so placed in recesses in the side of the trench, and so arranged that when a man retiring down a trench can catch

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hold of the roll as he passes a recess, uncoils it as he runs, leaving it in the trench in a badly tangled mass.

SECTION III. Supporting trenches may be at any distance from 30 to 300 yards behind the firing trenches. The C. T. in this section is constructed on the same lines, or may be constructed on the same lines, as Sections I and II, into whatever proportions local conditions and practical considerations, and particularly dangerous places, may dictate. The zigzag plan shown in the sketch is generally safe to adopt, as it allows rapid transit with a certain amount of concession to the claims of protection, more so as it approaches the fire trenches. These C. T.'s generally should be a series of straight stretches, zigzagging at acute or obtuse angles, the length and angles governed by local conditions, the extent and direction from which each stretch might be enfiladed, and the gradient and distance from danger. It has been shown before that the shorter the stretches and the more acute the angle at the turn, the less is the danger from enfilade fire, but the C. T. with this advantage requires a greater length of time and labor in digging, as well as taking a great deal more time and effort to pass through it. In order to lessen these things as much as possible,

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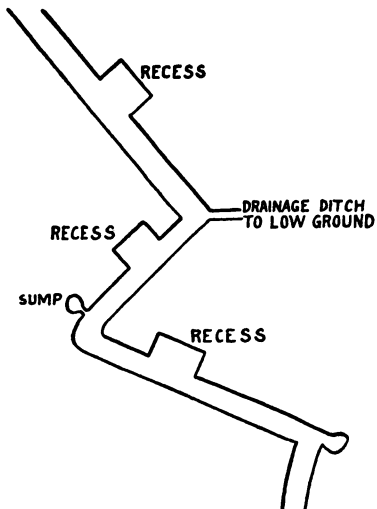

SECTION III
SKETCH OF TRENCH SYSTEM

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it is always considered best to adopt longer stretches and more obtuse angles as soon as possible.

The excavated soil is naturally thrown up on the side facing the enemy, and thus forming a parapet. It can at times be used as an actual fire trench. The parapet should fulfill the same conditions as the parapet of a fire trench, and where necessary, overhead traverses should be placed. The more of these overhead traverses used, the longer can the straight run of trench be. When running up-hill, facing the enemy, it is clearly obvious that acute turns and short stretches are necessary, or, if it is not found advisable to use these and more time can be gained by digging the straight runs, then they should be dug deeper and a great deal of care taken in placing the overhead traverses.

Generally, the farther the C. T. from the enemy, the less necessity to take measures for stopping hostile advance down it, but it is a safe thing when time permits to loophole the traverses facing the long straight stretches either in an ordinary traverse or when time permits the building of island-traverses, especially at junctions. Such loopholes command the straight stretch in front and are reached by narrow trenches very similar to a drainage

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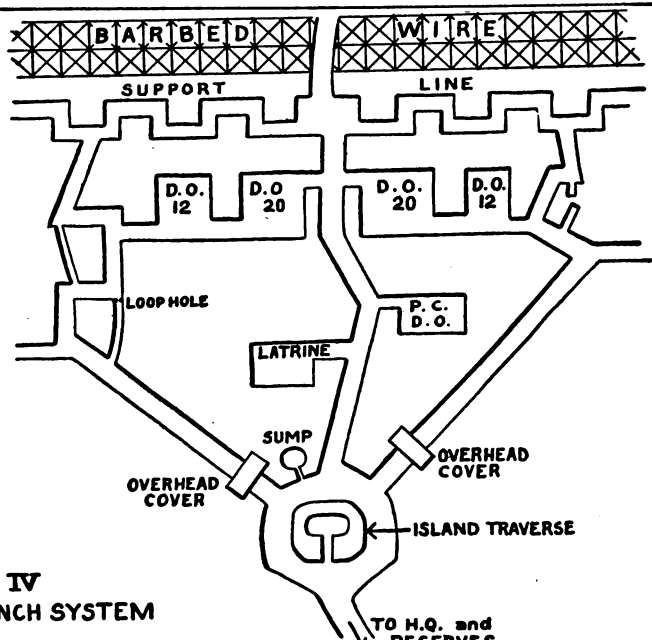

SECTION IV
SKETCH OF TRENCH SYSTEM

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trench, as indicated at "H." Here again, as well, the loopholes for at least one or two should be for kneeling fire.

Hostile attacks may also be hampered here by using the rolls of looped wire previously mentioned, or by frames of barbed wire placed at the side of the trench just behind the parapet, so that a man retiring down the trench can easily pull them down into the trench after him. Great care must be taken that C. T.'s running from firing line to support trenches do not obstruct the fire from the supporting trenches.

SECTION IV. Behind the support trenches the C. T. should be constructed on the traverse principle of *Section I*, so that the same defensive features existing for the support trenches as should exist for the firing line. In doing this, however, it should be kept in mind to provide rapid transit for troops behind these supporting lines. This is best done by continuing the zigzag system right through support trenches as shown. When necessary, this C. T. can be blocked.

It is always a possibility that support trenches may be lost, but not a probability. Therefore, undue weight should not be given against the convenience of adopting as soon as possible again the zigzag C. T. of *Section II*, the

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latter supplying all requirements of rapid transit and allowing the introduction of straight stretches in loophole traverses wherever required.

TELEPHONE LINES

It is generally found that artillery telephone lines are laid on the north and west side of a C. T.; infantry lines on the south and east, Lines are generally laid about two feet from the bottom of the trench, picketed inter-grooves being cut into the side of the trench. These lines must be given absolutely every protection possible by the infantry and by any one using the trenches. Far too much carelessness has at times existed which destroyed communication with artillery and infantry when it was of vital importance that it should be open.

Infantry in the trenches depend for immediate support upon their artillery, and if, through lack of supervision on the part of the officers in charge, these lines are destroyed or temporarily torn down by careless men not understanding their significance and importance, then that officer or officers is guilty of a very serious crime.

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RECESSES

These are usually made in C. T. to allow for the passing of troops or bearers of stretchers, or parties passing up and down to the line carrying the many things that are necessary for the upkeep of that line.

It is advisable that these should always be placed in the same corresponding place in each stretch, as shown in SECTION III, just before the turn, so that men know where they are to be found. The first man of a party coming up having arrived at a turn, and seen or heard others coming down, can give necessary protection to his party, and a great deal of unnecessary and very exasperating and fatiguing movements, and sometimes retracing of steps, is avoided. It is also often the cause of a great many casualties in a trench where these recesses are not made, as parties of men coming and going very often, while struggling to get past one another with their loads, are caught by heavy shell fire.

The recesses should be about 8 feet long and at least 2 feet wide, and the soil excavated from these recesses could be used for strengthening the parapets of the C. T.'s at these turns. Gen-

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erally, when time allows and energy permits, close to the firing line these recesses are made longer and deeper, oftentimes running to 12 and 18 feet long by 6 and 10 feet deep, although it is not advisable to crowd them too much. Recesses of this kind may also be heavily roofed and used as a very temporary shelter for stretcher cases, stores of bombs, ammunition, etc.

At every second or third stretch in these C. T.'s, either steps or an easy runway to the top of the trench should be made. This saves time on a great many occasions when parties coming over the top for speed and comfort find themselves stopped and have to take to the trench on short notice. It is also good when a serious obstruction occurs, and it is necessary to leave a C. T. and enter it again farther on.

NOTICE BOARDS

These boards should be fixed at every entrance and junction in a trench system, stating the name of the trench and the places to which it leads, and where there are trenches expressly for up and down traffic, these boards should tate it. Some people argue that such notices

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assist the enemy when they get into our trenches, but the argument does not hold as it is very often the case they do not know the names used in the sectors, as they vary up and down the line, and generally they have a very good idea of the system they will find themselves in anyway, and there is a very small chance that a majority of them will be able to read them anyway.

Care must be taken that these notice boards are not used for what is known as "boiling up," building fires, in braziers, etc., as the absence of these boards causes a tremendous amount of confusion when new troops are coming into the line. All officers must know the shortest routes from their own headquarters to those of companies on their flanks, as well as their own battalion headquarters, and every officer, N. C. O. and man must know the position of his immediate commander's dugout, as well as his company headquarters, and every man must know the name of the trench that he is in and helping to hold, and this is not possible when these notice boards are destroyed.

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TRENCH DRAINAGE

Efforts at drainage, which is the greatest trouble during the winter months to troops occupying the line, must be as systematic and thorough as possible. Tinkering is of very little use and brings no results but causes a great and tiring expenditure of labor as far as the men are concerned, with no end of work in sight. When taking over a sector of line, the drainage system must be thoroughly studied and a line of campaign mapped out and strictly adhered to. Thorough work in the initial stages will save any amount of subsequent unnecessary fatigue and labor. The system to be applied depends entirely on local conditions, but full advantage must be taken of the assistance which nature affords. Water running down hill is a marvelous fact; nevertheless it is often overlooked. Field drains and natural streams anywhere near the trench must be kept clear of obstructions. These are usually attended to by the overworked farmers in peace times, but as they do not work near a trench system, it must be looked after by the army. Neglect of the natural watercourses has been the cause of

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much of the difficulty of draining the trenches themselves.

During the winter months a trench is never really drained. A mixture in the trenches which is neither water nor good, sticky mud, but a beautiful liquid combination of water and dirt, which is thick enough not to run, is formed. Sometimes it becomes sufficiently like water to be pushed or assisted to run down hill with scrapers, boards, and anything else that is handy. Sometimes it becomes sufficiently heavy enough to be shoveled over the parapet or put into sand bags. In either of these cases it is only overcome by persistent labor, but when the mud is in its true clayed self it is a waste of time and labor to attempt to move it, and the only way, without a large amount of cursing, is to sit tight and pray for the sun to dry it.

When a valley or dip is close to the side of a C. T. a few narrow gullies through the side, of about 18 inches in width, should be made so that liquid mud can be swept along the trench and on through the gulley to a natural fall. These little gullies or ditches should start at a place or places where there are dips in the level of the trench and must be dug straight through the side, as it then becomes easier to keep clear and gives no obstruction to the flow of mud; but if

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facing the enemy, it should not be in a straight line, as it then allows rifle fire into the trenches. If no other way is possible, then overhead traverse or other means of protection should be taken at that point. Sometimes, when it is not possible to complete these gullies, they should be dug out as far as circumstances will permit and a block of soil or very large sods be put at the junction of the gulley to the trench and the liquid mud dipped out of the trench and dumped into the gulley, where it will be prevented from running into the trench again by these collections of sods. This process is very slow, but conditions frequently make it the easiest and most convenient way of ridding the trenches of some of the mud. This work can be carried on by what is sometimes known as a "trench patrol" or maintenance squad, which is generally detailed from the company in the support line and which patrols the system of trenches held by their battalion during the day. The N. C. O. in charge generally reports serious collapses to his company officer, who in turn reports it to the engineers, who immediately take steps to have it repaired.

The width of drainage gullies should not be less than 18 inches, thus allowing easy use of brushes issued. With these brushes and ade-

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quate gullies, very long stretches of trench can be kept in excellent condition when the trench is wide enough to allow the drying effect of wind and sun to reach the bottom. The time spent in making these gullies is saved over and over again. If there be no natural valley or dip, a sump-pit is generally dug, the size depending on the energy of the troops digging it, but generally it is about 10 feet below the level of the trench it drains, and anything from 8 feet on in diameter. It is dug some fair distance from the trenches and in a position that will allow the maximum amount of gullies to be led to it from that particular section of the trench.

After having this system worked out, the next thing is to ascertain what parts of the rest of the trench system will not be affected by this drainage, and there to dig similar sump-pits just to the side of the trenches drained, small gullies leading to them. These need only be about 6 feet deep below the trench level and 4 feet in diameter. A short gulley, 12 to 15 inches wide and 2 feet long, should lead from the trench to the sump-pit, as shown in sketch of trench system.

Sometimes the sump-pit may be semi-circular and cut into the side of the trench, but in this case some barrier must be put across it to pre-

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vent men falling in while traveling at night. The former system is far more satisfactory, and especially so when the trench is hardly wide enough to allow the passing of traffic without touching the sides of the trench.

Entrances to these sump-pits must always be kept clear of all obstructions. Very often a ridge of mud from a man's foot-mark is enough to put a sump-pit out of action. They should be continually emptied by pumping the contents over the parapet, or carrying in pails to the nearest gulley.

The side sump-pits must never be cut under the wall of a trench. On very short notice the roof will take the place of the excavated soil and there will be no sump-pit.

It is not always that pumps are available, and the few of those which are, are of no practical use for a length of time sufficient to be of any value; in fact, they hardly repay the fatigue entailed in getting them to the trenches. For ordinary trench drainage several small pumps are of far more use than one large one, as the range's limited by the difficulties of removing it or by the length of pipe attached. These pumps, whether large or small, must be given a large and substantial platform, placed in some central position among a number of

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sump-pits. Each pump must have not only a discharge pipe, but a suction pipe, the latter being movable from one pit to another in the pump's area without moving the pump. The placing of these pumps must be thorough and systematic, and those sump-pits not reached by pumps must be kept empty by means of pails.

FLOORBOARDS

Although these are rarely available in sufficient numbers to be laid continuously along the entire length of the trench, it is unwise to throw one down on a particularly muddy spot in a trench as a remedy. The result is that when it becomes covered with mud it sinks out of sight, and another one is thrown down with the same result. Then, when an attempt to drain is made, much to somebody's disgust they run into a layer of floorboards, quit work, and the trench never becomes drained. Patchy repairs to a trench bottom are as aggravating and as useless as bad revetment. When only a few floorboards are available, then they should be laid in one length and that length made as nearly perfect as possible, until more may be had, then that length continued. Patching here

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and there is of no use and never leads anywhere. Trench bottoms are treated in different ways up and down the line, depending on localities and materials on hand. In some places the trench bottom is of concrete blocks and bricks, with a small trench ditch of about 6 inches running along the side. This is not a very happy combination, as men traveling up and down the trenches at night with heavy loads sometimes stumble, their feet go in, the trench ditch becomes full of mud and blocked up, and your trench gradually becomes flooded up and down its length, unless very great care is taken. Where time and labor are available, long lengths of trench may be put and kept in good condition and the trench question partially solved if two rows of stout 4-foot sticks are driven well into the bottom of the trench, about 3 feet apart. Wooden rails are then nailed along the top of the stakes and cross-bars nailed and fastened to the rails. This work must be done thoroughly, though, or weak places will occur and become very dangerous for men traveling at night with heavy loads, as a fall through a hole in one of these bottoms generally means a broken ankle or some other accident.

In some parts of the line it has not been necessary to use anything for a trench floor,

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the ground itself being sufficient, with a small drainage ditch dug at the side, as in the case of those trench bottoms covered with cement and brick.

BRUSHWOOD AND STRAW

Brushwood should not be placed in a trench bottom, except under very exceptional circumstances, and, as a matter of fact, is very seldom used, its value lying more in the manufacture of hurdles. Once brushwood has been trodden into the mud it is absolutely impossible to remove it, and there is no means of removing the mud and properly repairing the trench bottom. Straw under no circumstances should ever be put in a trench bottom, and when put into dugouts or shelters, should be cleared out and burned where possible (which will not be in front line) as soon as it becomes sodden or sour. The floor of the dugouts and shelters must be thoroughly cleaned of all this old straw, sand bags and bad soil before fresh straw is put in. It is possible in large dugouts such as are found in reserve and support lines, to make bunks out of wire netting on the same style as the berth in a steamer, and in a modern dugout enough of these bunks may be made to accommodate a

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company. In all German dugouts this is the practice, although it is not possible in close proximity to the front line. Advantage must be taken of what material is at hand.

WORKING PARTIES

The routine of a battalion which is doing, for the sake of illustration, we will say six days in the trenches, is roughly as follows:

Six days are spent in what is generally known as a Brigade Reserve, which means living in the reserve dugouts or billets, depending on the closeness of a village to the firing line. During these six days the battalion supplies working parties to assist the battalion holding the line in the upkeep of its trenches. Very often this necessitates continuous work night and day for the men, more especially so during the winter months. At the end of the six days they go to the trenches and are in turn assisted by the working parties of the battalion relieved.

These working parties may sometimes be actually in the front line with the battalion that relieved them, or on the communication trenches leading to the front line, or on the second line defenses or reserve and support dugouts. This work is carried on under the supervision of

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engineer officers generally acting under orders from their brigade and divisional commanders. A request is made daily through the battalion commander for so many men to form the various working parties for that day and night, and the battalion commander keeping the brigade or division informed of his actual strength, protects his battalion from impossible allotments of work. These working parties are then detailed with the officer in charge, and he is generally given sufficient notice that he may have some idea of the task ahead of him. It is then to that officer's benefit, knowing the amount of men who will have to do the task and what the task is like, for him to study out before leaving for the place where the work is to be done, just exactly what he intends to do and what sort of an organization it will require to do the work with the least possible friction.

This is absolutely essential, as naturally men coming from a six days' tour of the trenches and being ordered on a working task, are not keen on the job, and when an officer has not studied beforehand what he intends doing and how it shall be done, it winds up in endless confusion, disgusts the men more than ever, and precious little work is done.

Reliefs. The total time occupied in digging

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trenches is generally divided into parties called reliefs, usually of four hours. Shorter periods than this means much time wasted in commencing work and in delays; but, as a matter of fact, the time spent on the job and going to and from it will run to from 7 to 10 hours.

In digging trenches, the usual extension is to two full paces per man. Where there is little probability of attack the following method may be adopted: Halt party about four paces in rear of the left flank of the general line of trenches required to be dug; then form single rank, march ahead of party to the commencement of task and indicate to the first man his task, stepping off the next two paces for the next man, and so on until you have your party all placed. This takes a very short time and is one of the best methods. Allow the men to remove their equipment, but do not allow them to throw it any place they like. It is a general rule to place it about four paces to the rear of their task. Where attacks are possible, rifles must be kept within easy reach.

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TRAVERSED FIRE TRENCHES

The following is a method for extending men to dig by night a traversed and recessed fire trench which is not already traced:

1. Detailing a covering party to guard against sudden attack.
2. Extension of the remainder to two paces.
3. Number quietly down the line by 4s.
4. Nos. 1 and 4 stop 2 paces back (these men then become traverse men).
5. Nos. 2 and 4 drive in their picks (half way between themselves and left-hand neighbors and in line with their toes).
6. Front rank to mark out tasks (Nos. 2 and 3 commence from the pick between them and mark out 7½ feet each way, that is, 2½ pick-handles' distance).
7. Rear rank mark out tasks (commencing from pick between Nos. 1 and 4 to end of each recess).

As soon as this is done the men commence work, the officer going down the line at once to check any errors before they have gone too far. While this may sound very complicated it will

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be found that after a little training the men become accustomed to it and it is a very simple matter. This method renders unnecessary the giving of many orders in the dark once the men are extended, and prevents a great amount of confusion. There will always be a slight amount of readjustment of the work, such as the widening of traverses, etc., but it is easily done after the work has been started and even after the trench has been dug to some depth.

OBSTACLES AND ENTANGLEMENTS

The purpose of an obstacle is to obtain the control of the enemies in respect to direction and speed during an attack, and to deflect troops into areas favorable to their destruction by the defenders. They break up the unity of action, deflect parties isolated into the best swept fields of fire and hold them under close fire of the defenses. An obstacle should be close to the defender's position, not more than 80 yards away at the most. A system is now in use on the Western Front where entanglements in front of trenches are placed approximately 20 yards from the parapet, as that has been found to be the distance at which the deadliest

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bombing can be done. They should be sheltered or screened, when possible, from enemy artillery, giving no cover to the enemy and be so placed as to surprise the enemy. They should not interfere with any counter attack necessary to be made and have occasional gaps, which may be mined. Types of obstacles are low wire entanglements, their height depending on the condition existing in No Man's Land; high wire entanglements, barricades, mines, inundations, etc. Wire plays the important part in most of the obstacles now being used on all fronts, and is generally used, first, as a trip wire stretched just above the ground, or fastened in loose coils to short pickets. Flares and alarm guns and tin cans may be used in connection with this; second: a simple fence to cause delay and confusion to the enemy at night; third: as a concealed obstacle in fords and standing crops or long grass; fourth: as a help towards making hedges and brushwood impassable, and as a wire entanglement solely.

The wire entanglements are the best obstacles, as they are quickly and easily made, are very difficult to destroy and offer no obstruction to fire in view of the defenses.

Low Wire Entanglements. Stout sticks, 36 inches long and 1½ to 2 inches in diameter, are

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driven into the ground on level at 6-foot intervals. These should be driven in at least three rows so arranged that the sticks in one row are opposite the centers of gaps in the next. The heads of the sticks are connected by strong wires crossing diagonally from 12 to 18 inches above the ground.

High Wire Entanglements. To be effective, high wire entanglements should prevent the enemy from crawling through it at or near the ground level, and when possible, should be screened from enemy artillery observation. This obviously is utterly impossible as far as wire entanglements in front of the firing line is concerned, but it is possible to a certain extent to screen these high entanglements from observation in front of support lines and second line systems. Under conditions existing at the front, the wire work is often and generally, for very good reasons, of a hasty character, and it is best, therefore, to limit the first stage to just enough to form a nucleus of the whole entanglement, in order that the required area may be covered by obstacle before serious interruption occurs. To do this, the obstacle is best constructed in two zones, with a small space between. The pickets should be from 5 to 8 feet long and average five inches in diameter, being

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placed at irregular distances and with varying heights in order to make more difficult the passage over them by means of hurdles and planks. The outer pickets should be very firmly driven and stayed to prevent the enemy dragging the obstacle away. It is also nice to drive large nails into the tops of the posts with half their length projecting. After the posts are driven in, they are first joined diagonally, that is, from head to foot and foot to head, by winding the wire around each post and securing it by staples. Each set of posts should be stayed by four wires. There should be a trip wire 9 inches from the ground, or even less, running continuously round the outer posts, and another one foot from the top of the middle posts. The barbed wire can then be hung in festoons between the posts on no fixed pattern and fastened to them. It must also be fastened to the other wire where it crosses, by short lengths of wire especially cut beforehand. Slack wires are of more hindrance when cut than taut wires. Tight wires help the enemy's advance by giving support to hurdles and other methods used to get across these entanglements. One method once used by the Germans was the carrying out of mattresses and endeavoring to cover the wire obstacles in that manner, and had the

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wire been taut it would have been a success, but as it happened, it was not.

The ground on the enemy's side and within the entanglement, as a matter of courtesy, is strewn with broken glass and tangled wire. The whole system of entanglement should be under well-controlled machine gun fire from special points and should be widest where the fire of the defenders is least effective by night. There should be one sentry at least to each 50 yards of entanglement.

Abatis. A form of obstacle made by trees cut down and laid side by side as close as possible with their branches towards the enemy is used. These should be in a hollow and screened from view to make it of any value. The butts of the trees should be firmly secured by burying them in the earth, or by laying logs of timber across several butts. Wire and barbed wire must then be interlaced between the boughs, which should also be sharpened to points on the enemy side. Some of the lower branches may be pegged to the ground, if thought necessary, to insure the maximum resistance.

Barricades. These are used for the defense of streets, roads, bridges, etc., and are made of any available materials, including furniture and vehicles, either overthrown or with wheels re-

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moved, carts filled with earth, railings, bales of goods, etc. Where trees are growing along the roadside, fell them across it and entangle with wire.

It must be kept in mind, though, that passages are required through these barricades to allow outposts to advance or retreat, that these passages, viewed from the front, must not appear as openings. To avoid this the barricade should be made in two parts, one overlapping the other. Sometimes, where there is a gap in a row of houses, or a sharp bend in the road, a barricade may be made in one part and a passage round one end left for traffic.

Inundations. They may be formed by damming streams at convenient points, specially in the valleys, or by damming up the arches of bridges. In the latter case, care must be taken not to endanger the stability of the bridge. The ditches of field works form a good obstacle when flooded. Destroyed trenches in front of a breastworks may be filled with water, and with barbed wire thrown into it, will prove an effective obstacle.

Fougasses. These are used in connection with obstacles and are really land mines loaded with stones, bricks, etc. An excavation is made in conical shape with an axis inclined to about

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40 degrees toward the enemy horizon. A box of powder is then placed in a recess at the bottom and on the box is placed a wooden platform or shield 3 to 4 inches thick, over which stones are piled.

A fuse is placed in a groove cut at the back of the excavation. A line of least resistance must be so arranged that by placing the excavated earth on the back edge of the fougasse, the powder will act in the direction of the axis and not vertically. A fougasse charged with 80 pounds of powder may be constructed in this manner to throw five tons of brick and stone over a surface about 160 yards long by 120 yards wide.

All of the foregoing are labors of working parties, as well as construction of dugouts, carrying of supplies, ammunition, etc., drainage and building of the trenches and the many other jobs behind the lines. Always, no matter how small the job, careful forethought must be given to the planning and arrangement necessary to carry it out.

ORGANIZATION OF BOMBING SQUADS

Every infantry soldier must and does receive instruction in grenade throwing. Some men

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do not possess the temperament and qualifications necessary to make efficient bombers, and for this reason in every platoon there should be a bombing squad of one N. C. O. and 8 men, with a higher degree of training and efficiency as bomb throwers than the remainder, although all hope must not be given up for the remainder.

These men are available either to work with the platoon or to provide a reserve of bombers for any special job, such as raids, cutting-out parties, and clearing trenches just occupied. Only the very best men in each platoon should be chosen, taking into consideration physique, courage and steadiness, although it is not always the big man physically that makes the best bomber. The responsibility for the training of these men rests with the battalion and company commanders.

TRAINING

The first step is to overcome a man's natural fear of the grenade itself. This is only done by explaining how it is to be used, the method of lighting and the length of time taken for the fuse to burn. A good idea is to have some of the fuses of the length used lighted and the men

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told to count while the fuse burns out. Dummy grenades with fuses attached can then be introduced and the men taught to light them, observing carefully how long it takes for the fuse to burn down to the grenade.

The second step is to develop accuracy in throwing. Normally, the bomb should be bowled overhand, although it is certainly not wrong to throw, but it has been found in tests that a man throwing bombs has tired a great deal quicker than a man bowling them overhand.

Stick grenades may be thrown over short distances like a dart, although this is unhandy and can only be done by a carefully trained man. Great care must be taken while in the trenches in throwing percussion bombs, as very often a man swinging his arm back to throw such a bomb has exploded it in the trench, with disaster to himself and those near him.

Men should be taught to throw standing, kneeling and prone. It should be impressed upon them from the beginning that if a grenade with a time fuse is dropped in the act of throwing there is ample time to pick it up and throw t out of the trench before it explodes, but this nust be done immediately.

A is a diagram of a bombing field where men are trained in practice with dummy bombs. 1 is

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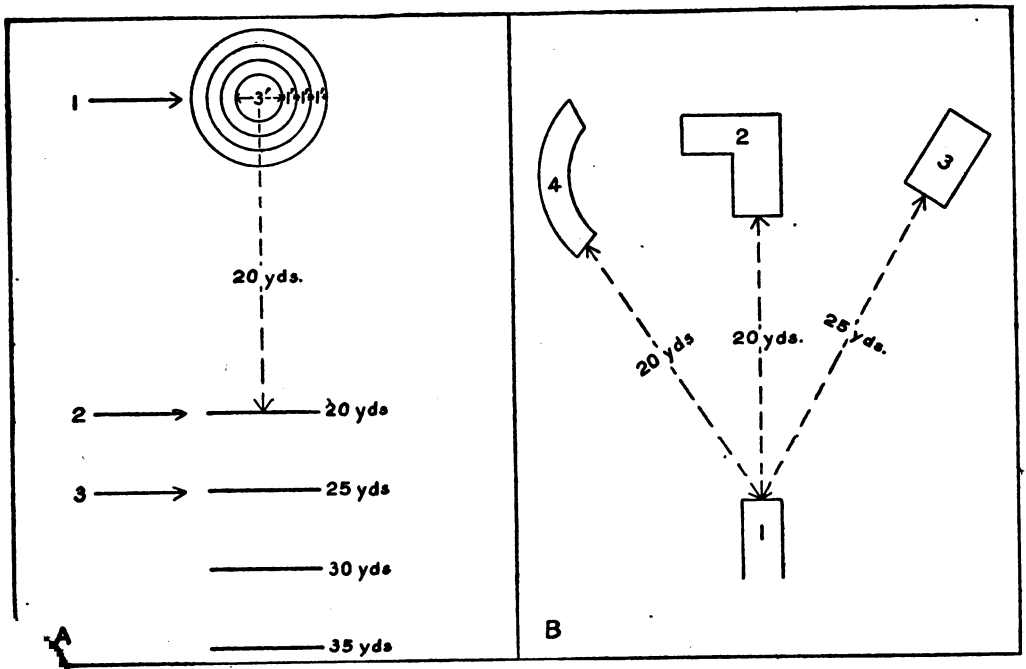

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the target marked on the ground and having the same general plan as a firing target, with Bull, Inner, Magpie, and Outer, the score counting 5, 4, 3, & 2 respectively, or according to the instructor's taste. 2 is the first line, 20 yards from the center of the inner ring. The men *must* be trained to a high degree of accuracy at this range. 3 is the second line, 25 yards from the center of target. There are lines every five yards back until the 40 yard line is reached, which latter is the extreme range for bombing practice.

At each range the men should practice standing, kneeling, and prone. At 35 and 40 yards bombing from the kneeling and prone positions is very difficult and the time spent on practice here should not interfere with the obtaining of great accuracy at the shorter ranges.

At all ranges the men should be allowed to throw any number of dummy bombs, but should not be permitted to fatigue their arms.

B is a diagram showing the arrangement for trench practice with dummy bombs. Small trenches are built on the surface of the ground by screens of wire mesh covered with burlap or other similar material. 1 is the thrower's trench and is built so high that he cannot see over the top. From this he throws, using a periscope

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for observation. 2 represents part of a traverse and fire-bay, the front part of which is about 20 yards from the throwing trench. 3 is a section of straight trench about 25 yards half right from the thrower's front. 4 is a section of curved trench about 20 yards half left from the thrower's front.

The general custom in the practice trenches is to give the man any desirable number of dummy bombs, say 18; 6 for each trench. Four out of six are required to be put in No. 2, and 3 out of 6 in Nos. 3 & 4. Men must not be kept at bombing practice too long at a time as it spoils both their interest and their aim.

In taking a line of trenches, it is well to remember that the attack will take place on a relatively small front by a large number of men, and therefore when the trenches are finally reached, there is liable to be great overcrowding in them. This can only be prevented by extending them along the trenches as quickly as possible, and is of the utmost importance as heavy casualties will result from allowing this overcrowding. To make this extending possible, it is the duty of the bombing parties to work along to both flanks of the trenches and take advantage of the temporary confusion of the enemy by obtaining as much of his trenches as possible,

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thus allowing for the extension of men. In a narrow trench the only portion of an attacking party coming into contact with the enemy is the head, or what is known as the Bayonet Man. The bombing party is composed of the following:

1. Bayonet man,
2. First thrower,
3. First carrier,
4. First spade man,
5. N. C. O. first squad,
6. Second bayonet man,
7. Second thrower,
8. Second carrier,
9. Spade man, in charge of second party.

These parties will work up a trench until they come to a junction, when the first party in charge of the N. C. O. will continue straight on and the second party branch to the right or left, as the case may be, and as they come on other parties keep working up behind them, and the infantry gradually following taking possession of the line and starting consolidation work at once.

Communication throughout these lengths of grenade parties is very difficult with men ex-

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tended in single file, and the attendant confusion which accompanies such a stand.

A system is required which will enable supplies of bombs to be passed up and casualties replaced automatically. This system cannot be laid down on any cut and dried lines, but must be figured out before the attack, with due consideration being given to the line of trenches to be attacked and the difficulties which will be encountered in getting supplies to that line, and it is only on the spot that such a system can be worked out.

During an attack three grenades per man are issued to each unit detailed to open the attack, and these grenades are turned over to the bombers or used by the men themselves if necessary. When out of grenades themselves, the men take over the casualty's, and it is the duty of a casualty when he is so able to, to leave his grenades and ammunition to the care of some other man before "going down." Small depots should be established at frequent intervals along the trenches from which the attack starts, with careful consideration given to their safety from shell fire, if at all possible. Other depots must be established in the support and assembly trenches, and these will generally be supplied

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through a central station probably controlled by a brigade or division.

Before starting the attack, every man and party should have had explained them in detail exactly what is required of them, and generally the following system is adopted:

First bombing party of group—
Two bayonet men to protect grenade throwers,
First bomber,
First carrier,
Second bomber,
Second carrier,
Group leader (N. C. O.),
Two bayonet men to protect the group leader and the rear of party.

Second bombing party—
Formation as above. The head of the party must be in touch with the rear of the first party. Officer commanding in rear of second party.

Third and fourth bombing party—
Formation as above. Second in command in touch with rear of fourth party.
Machine gun detachment, if available or considered necessary.

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The machine gunners are generally used at the rear of a party, so that they can bring their guns into action from behind and sweep the top of the ground around the trenches being attacked, in order to prevent an overland attack on the bombing party. In all these formations the number of men detailed must allow for casualties. Rapidity of movement is essential, as crawling and stalking will give the waiting enemy an advantage. The leading bayonet men generally move along the trench, from corner to corner, in a succession of rushes, followed by first bomber, and the thrower hurls as directed by the bayonet man. The duty of the bayonet man is to protect the thrower and carrier at all costs. Second bomber and carrier follow the leader, keeping one corner behind to replace casualties. Each party must be regarded as reserves to the party in front, and some method must be found every time a new attack is carried out for giving the aerial service notice of trenches occupied. If the head of a party is checked, that which has been gained must be held by throwing up a barricade. In all attacks bombing parties are supported by a party of sand-bag men, under an experienced N. C. O., so that while bombers keep

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the enemy at bay a strong barracade may be put up as quickly as possible.

This is generally done by placing what is known as a demolition tube about 1½ feet from the bottom of the trench and in each side of the trench. This will bring down enough of the sides of the trench to make a good enough barricade for the moment, but great care must be taken that while watching and protecting the barricade the enemy do not come overland and drop in behind the barricade, with disastrous results to the garrison.

Although the main defense of a line of trenches is infantry supported by artillery and machine gun fire, parties of bombers should be distributed throughout the front system of trenches. The best position is in the support trenches close to the main communication trenches, where they can make an immediate counter-attack should the enemy succeed in gaining a footing. A bombing trench back about 20 yards in the rear from which bombs may be thrown into the front trench, is a distinct advantage.

The bombs stored in the trench should be kept ready-fused and with detonators inserted. They must be distributed in a number of dry, enclosed, as nearly as bomb-proof depots as pos-

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sible, established at frequent intervals along the trenches. A good type of grenade depot is one built in a "T" shaped trench, slightly off the main trench.

EXPLOSIVES

Relative strengths of explosives: Gunpowder 5; cordite 8; dynamite 9; guncotton 10; gelignite 10; gelatine dynamite 11; blasting gelatine 12. Guncotton is available in two forms, wet and dry. The dry, while being utilized in making bombs, is mostly used to explode the wet guncotton. For this purpose it is made up in one-ounce primers, which are perforated in the center for a detonator. These primers are packed in metal cylinders, each containing ten threaded on a tape. Each case contains six cylinders. In this state, although not as powerful, dry guncotton is much more dangerous to handle than wet, being susceptible to both shock and friction.

Wet guncotton is that which has absorbed 30% of its weight in water, and is made up in 15-ounce slabs 6 x 3 x 1⅜ inches, and packed in tin foil and air-tight boxes containing 16 slabs each.

Whether wet or dry, guncotton, like other ex-

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plosives, can be exploded by one detonator, so long as the charges or slabs are in direct contact with each other.

Dynamites include the following compounds: (1) dynamite; (2) gelignite; (3) gelatine dynamite; (4) blasting gelatine. All of these are now being used. Their advantages over guncotton are that, being soft and plastic, they can be used in bombs where it would be impossible to use guncotton slabs or primers on account of size and shape. Dynamite and its compounds freeze very easily (42° F.), becoming hard and brittle. In this state they are exceptionally dangerous, and they should be thawed before use, but this process should not be attempted by any one other than a competent person. Wooden implements should always be used for cutting and piercing holes for detonators in any of these explosives, and care should be taken to protect them from damp, as when wet they become highly dangerous. Dynamite explosives are usually supplied in parchment cartridges weighing two ounces, and are packed in boxes of 5 or 50 pounds.

Lyddite and picric acid are both high explosives, used mostly in shells. They are easily melted and in this way the shell is filled. They are very safe and difficult to detonate.

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Ammonal. A new explosive which is absolutely safe to handle, not being sensitive to shock or even bullets. It does not freeze and can only be exploded by means of a detonator. It easily absorbs moisture and should be kept dry.

Cordite. Is made in strands and is the explosive used in small arms ammunition.

BOMBS

There are three kinds of bombs: (1) *percussion;* (2) *ignition;* and (3) *mechanical.* It is not possible to describe every bomb in use under these three headings, but the most typical are selected for description, although it does not follow that they are all in use at the present time, but will give a fairly good idea of what is required.

Percussion Bombs.

1. Hand Grenade No. 1.
2. Hand Grenade No. 2, formerly known as Mexican Hand Grenade.
3. Rifle grenade No. 3, formerly known as Hale's Rifle Grenade.

Hand Grenade No. 1 consists of a brass case

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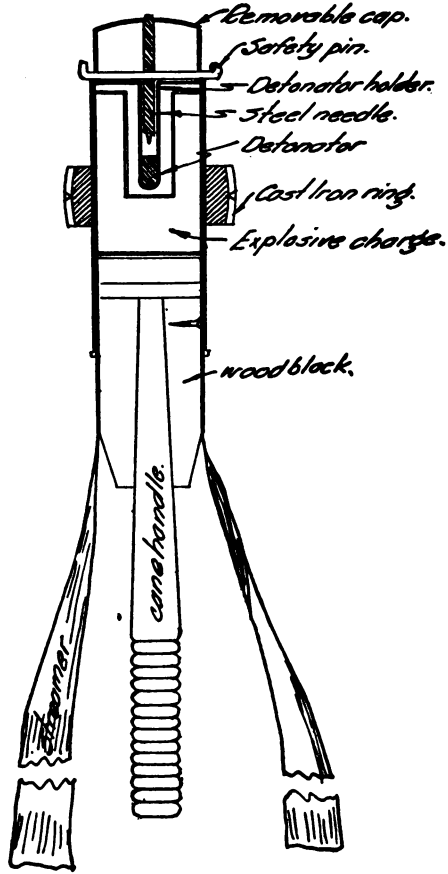

Length complete 12½"
Length of handle 5"

HAND GRENADE NO. 1.

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screwed on to a block of wood, to which is fixed a small cane handle about half way up the case. Outside it is a cast iron ring serrated into 16 parts. The upper end is covered by a moveable cap with a striker pin in the center. On the cap are the words "Remove," "Travel," and "Fire" in duplicate. These are marked in red and can be made to correspond with red pointers painted on case. To prepare a bomb, turn cap so that pointer is at "Remove," take off cap, insert detonator in hole and turn it to the left until the spring on the flange is released and goes into position under the pin; replace cap and turn to "Travel," which is a safety position. When the bomb is to be thrown, turn cap to "Fire" and then remove safety pin. This bomb explodes on impact, and to insure its falling on the head, streamers are attached. Care should be taken that streamers do not get entangled. The bomb must be thrown well into the air.

Hand Grenade No. 2 is similar to the above, except that a special detonator is screwed in from the head, and that the striker pin, in this case, is at the bottom. The detonator having been inserted in the bomb is ready for throwing as soon as the safety pin has been drawn.

Rifle Grenade No. 3, more commonly known

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as Hale's Rifle Grenade, consists of a serrated steel case filled with T.N.T. and a composite explosive. At the bottom of the case is a brass ring fitted with wind vanes, which keeps in place two small steel retaining plugs, securing the striker. In order to prepare this grenade for firing, the steel rod attached must be put down the bore of the rifle. The safety pin is then withdrawn, the collar pulled down and the wind vane given a slight turn. The rifle is then loaded with a special cartridge containing 43 strands of cordite. When charging the rifle the bolt must be well pushed home. When the rifle is fired, the explosion of the cartridge speeds the grenade on its way and the air passing through wind vanes causes the ring mentioned above to unscrew, and the two retaining plugs to fall out. The striker is now free, and when the grenade reaches its destination and comes in contact with the ground the shock compresses the creep spring and the needle of the striker is forced into the detonator, exploding the grenade.

Special screw-in detonators are supplied with this grenade, as well as in Grenade No. 2, and care should be taken not to mix the two detonators, as the Rifle Grenade Detonator is slightly longer, and if fixed in the wrong gre-

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nade will cause premature explosion and much sadness. These grenades have an accurate range of from 250 to 350 yards.

Ignition Bombs. The following bombs come under this heading:

Hand Grenade No. 6.—Grenade light friction pattern.

Hand Grenade No. 7—Grenade heavy friction pattern.

Hand Grenade No. 8—Formerly known as double-cylinder light pattern.

Hand Grenade No. 9.—Formerly known as double-cylinder heavy pattern.

Battye Hand Grenade.

Pitcher Hand Grenade.

Oval Hand Grenade.

Ball Hand Grenade.

Hand Grenades Nos. 6 and 7 consist of metal cases filled with T.N.T and a composite explosive and are exactly alike, except that No. 7 contains shrapnel bullets or scrap iron, while No. 6 contains only explosive. At the top of each case is a place to fix the friction igniter, which is supplied separately. When these bombs are to be used, detonator fuse and igniter are put in and firmly fixed. Before throwing the becket on, head of igniter should be pulled smartly off.

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Hand Grenades Nos. 8 and 9 are similar to the above, except that the fuse is lighted by a Nobel Patent Lighter. The *Battye Grenade* consists of a grooved cast iron cylinder filled with explosive. The top is closed by a wooden plug pierced centrally for insertion of detonator and fire.

The Pitcher Hand Grenade is very similar to the Battye, only different in that it is slightly heavier and having a different patent lighter. This lighter is somewhat complicated and special instructions should be given before the grenade is used.

The Nobel lighter consists of two cardboard tubes, one fitting over the other. Inside the top end of the outer tube there is a layer of friction composition; fixed to the top end of the inner tube is a forked brass friction head, which is held in position by a safety pin fastened through both tubes. Inside the other end of the inner tube is a small copper band, into which the fuse is fitted. At the joint of the two tubes there is a narrow tape band with a loose end. To light the fuse, pull off tape and safety pin, then press down outer tube and turn slightly. This lighter has a five-second fuse attached.

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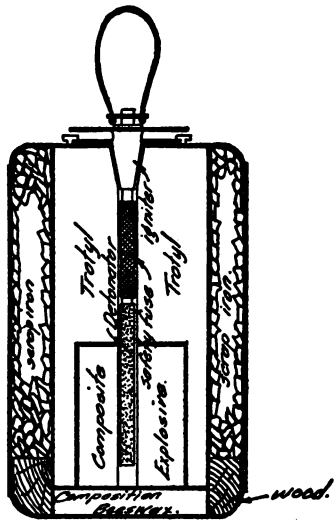
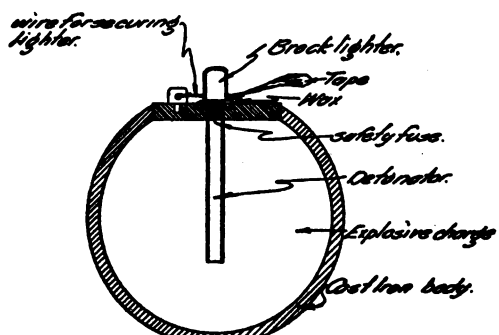


SECTION.
Dimension of Cylinder 4"x2¼"

HAND GRENADE No. 7.



SECTION.
Diameter of Grenade 3"

BALL HAND GRENADE.

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The Oval Hand Grenade is an egg-shaped cast iron receptacle filled with ammonal. One egg has a steel plug and the other a flanged brass plug bored centrally, to which a hollow copper tube is fixed to take the detonator. This grenade is set off by a Brock fuse and lighter.

The Ball Hand Grenade consists of a cast iron sphere, 3 inches in diameter, filled with ammonal and closed by a screwed steel plug which has attached to it a covered tube to take detonator in the center of grenade. It is also lighted by a Brock lighter.

JAM-POT BOMBS. In the early stages of the war it was found necessary to make bombs on the spot. The material used was generally a jam tin filled with shrapnel bullets, scrap iron, powdered glass and grass, etc. This was exploded by 2 one-ounce primers, two ounces

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The Brock lighter consists of a match-head and fuse combined. The head consists of a small cardboard cup filled with friction composition and covered with waterproof paper. With this type of lighter an armlet covered with match composition is worn by the bomber on the left forearm. To ignite fuse, first pull off waterproof paper and then strike head against armlet. Time of fuse 5 seconds.

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gelignite, blastene or ammonal, and detonated by a No. 6 or 7 detonator, to which was attached a five-second fuse. The time could be regulated by length of fuse.

MECHANICAL BOMBS. *Hand Grenade No. 5,* known as *Mills' Hand Grenade.* Mills' Hand Grenade No. 5 weighs about one and one-half pounds and is in constant and steady use at the front, being the best known of all grenades. It consists of an oval cast iron case, containing explosives and serrated to provide numerous missiles on detonation. In the center is a spring striking pin, kept back by a lever or handle, which, in its turn, is held in position by a safety pin.

Detonators and percussion caps connected by a short length of fuse are supplied with these bombs. When the bomb is to be used the bottom is unscrewed and the combined detonator and percussion cap is inserted in the space provided for it, the percussion cap being placed in the boring under the striking pin. When this is done the bottom is screwed on again as tightly as possible, using the special spanner provided for this in each box. Before throwing, the safety pin is removed and the bomb held with the lever in the palm of the hand. When the bomb is actually thrown the lever or handle is

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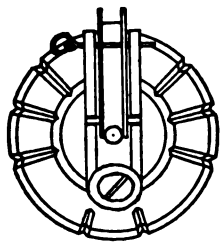
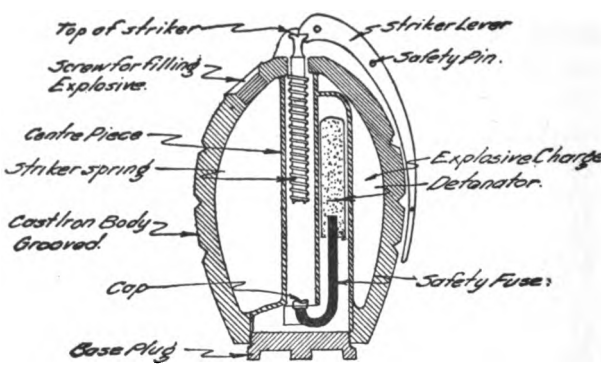


PLAN.



SECTION.
Dimensions of Grenade 4" x 2 3/8"

HAND GRENADE No. 5 (MILLS).

released; this releases the spring, which forces striker down on to the percussion cap, ignites fuse, sets off detonator and explodes bomb.

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GAS WARFARE

The use of poisonous and asphyxiating gases, which was first adopted by the Germans in the Ypres salient in April of 1915, is now becoming an accepted fact in the present war. It is to a certain extent in one shape or another, before one every day of his life in or near the trenches. Every one should therefore be well acquainted with the various ways in which gases are used in an attack, as well as precautionary methods to be taken in counteracting its effects while on the defense.

In an attack there are only two methods which can be used—emanation and shells and grenades. The emanation method can only be employed under very favorable circumstances and in a few cases where rather a long chance was taken, it reacted very badly on the enemy. The first thing to make a gas attack successful must be a favorable breeze of about five miles an hour, as if the wind blows any faster it does not give the gas a chance to settle down into the trenches. The object of this gas is to create a poisonous and irritant atmosphere, and this is accomplished either by a gas forced through

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tubes in the direction of the enemy, or a liquefied gas stored in cylinders under very high pressure. To be successful, as before mentioned, the wind must be a steady breeze of not much over 5 miles per hour, no rain, and the element of surprise must figure very largely. The gas used must be heavier than air and not allow of being held back by any protective measures taken by the enemy. If the wind is too strong, it is obvious that any gas employed will be carried too quickly over the enemy's trenches, so that it cannot settle to any degree which will allow of its obtaining the desired effect. If the wind is too light, it will be carried up into the air by local eddies, or may even be blown back.

For these reasons it is impossible to fix a definite hour for gas attacks, as everything depends on the wind.

Arsenic and phosphorus compounds are used in the tube method, and their presence can be detected at once by the smell of garlic. Should such gases get into your own trenches, chloride of lime scattered freely about will disperse them.

The gases used in liquid form from cylinders are a mixture of chlorine and other matter annoying to the ordinary infantry officer and

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soldier. If successful in surprising the enemy, their trenches should be cleared at once, but if the element of surprise is not there and time is given for defensive measures to be taken, the effect is lost. In an assault following a gas attack, men should always wear smoke helmets for at least 30 minutes after the gas dissemination has ceased, and the assaulting party must have the strictest orders not to remove their helmets until the officer in charge has given the command.

In the shell and grenade method of dissemination, shells and bombs are used containing liquid gas, or a substance which gives off irritant fumes.

It is easy to tell a gas shell when it lights as it comes down, the same as a "dud" shell; that is, one which does not explode, the outer casing of the shell simply collapsing. The liquid soaks into the ground, and men should be warned against standing over this ground and inhaling any of the fumes, which are very slight and rather hard to notice but very powerful and with very quick action. When a man thinks he has inhaled any of this gas he should at once be made to lie down, not undergo any exercise whatever, and as soon as possible have him

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carried out on a stretcher to the dressing station.

Tear shells, which are used in great profusion during an attack, are for the moment blinding in their effect, causing smarting of the eyes and a great amount of watering. This effect is only for a minute, and the men must be impressed with the fact that if they continue moving forward instead of sitting down and rubbing their eyes, it will pass off almost at once. These shells are also greatly used against the artillery during heavy bombardments. Adequate protection is furnished in the shape of goggles to fit over the eyes, as the gas has no other effect whatever.

As in other branches of military art, the best means of learning defense is to have a thorough knowledge of attack. Thus, direction of wind must always be noted, and if favorable for an enemy attack, special observers must be placed to give warning and surprise guarded against in every way. Sentries are specially placed in the trench, and often in listening posts, to get early warnings of an impending attack. If a sentry at a listening post discovers that a gas attack is being made, he at once warns the sentry at the end of his cord or wire, giving a pre-arranged signal. This sentry passes the

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alarm on a Strombon horn, which is something similar to a Klaxton, and will automatically give a warning which can be heard for 3 or 4 miles, and which lasts about a minute.

When a horn is not in use, generally shell cases are hung in the trenches. These are beat on by the sentry who is warned and taken up all along the line. It is then the duty of that sentry not for the instant to put on his gas helmet, but to proceed along the front line waking all the occupants of dugouts, etc., who may be sleeping in the area guarded by him. Every man without exception stands to in his trench with his helmet on and will not reënter dugouts until first given permission by officer or N. C. O.

These attacks are generally carried out, when possible, just before dawn or during the middle of the night, and the only warning given before the actual gas reaches a trench, is a slight hissing sound which is made and can be easily heard as the gas escapes from the cylinder. Great care must be taken when the wind is favorable for an attack that this sound be listened for.

Any man wounded during a gas attack must not be placed in a dugout or on the bottom of a trench, and even if considerable shell fire be going on it is far better that he be laid out in the open on the top of the ground, where he will

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have a far better chance than lying in the bottom of the trench or in a dugout. After gas has passed through a trench system, and before the officer thinks that it is safe to remove the helmets, the trenches must be sprayed with a machine known as Vermeral Sprayer. A man with this sprayer on his back and wearing his helmet, slowly traverses the trench working the spray. This small tank on his back is charged with nothing more or less than "hypo" (sodium hyposulphite), about 6 pounds of which is dissolved in a bucket of water and a handful of ordinary washing soda added.

Garden syringes and buckets may be used if sprayers are not available, but their effect is not so quick.

When the officer thinks that the trench has been sprayed sufficiently and all gas has gone, he may then allow the men to take off their helmets, but not to reënter their dugouts until they have been thoroughly cleaned.

This is sometimes done by fanning the gas out, sometimes by building a fire and smoking it out, and by the use of the sprayer. Great care must be taken that no one enters until every last vestige of gas is gone, and it is generally well that the medical officer should inspect infected dugouts before allowing the men to return.

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GAS MASKS OR RESPIRATORS

The Box Respirator at present in use on the Western Front is the latest improvement, and proof against any gas that so far has been used, but should such a thing happen that a man be caught without his box respirator, any of the following improvised methods are good:

1. Wet and ring out any woolen article, such as a stocking, muffler or cap comforter, so as to form a thick pad large enough to cover the nose and mouth, and press firmly over both.

2. Place in a scarf, stocking or handkerchief, a pad of about three handfuls of damp earth, and tie firmly over the nose and mouth.

3. A wet cap comforter will be found useful as additional protection, especially against certain gases other than chlorine.

4. A cap comforter wetted with water and soda solution or tea, folded into eight folds and firmly held over the nose.

5. A sock folded fourfold similarly wetted and held or tied. If the sock or comforter has been soaked in soda solution it will act efficiently when dry, though, if possible, it should be moist. The spare tapes from puttees may be used for tying on the sock or cap comforter.

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6. Any loose fabric, such as a sock, sandbag, woolen scarf or comforter, soaked in urine, then wrung out sufficiently to allow of free breathing and tied tightly over the nose and mouth.

In the absence of any other cloths, the flannel waistbands issued for winter use could be used for this purpose.

Every officer defending a trench against an enemy gas attack should endeavor to collect information whenever possible to be sent to headquarters regarding the capture of apparatus used by the enemy either for disseminating or protection from gas. If a gas shell attack is made, unexploded shells or portions of them should be sent; the time of day, duration of attack, color, taste or smell of gas used, effect on the eyes, breathing, and all other symptoms should be noted. New gases may be used at any time, and speedy information greatly helps the adopting of protective measures.

The area of the gas attack is very large and will sometimes cover as far back as 12 to 15 miles behind the lines, although at that point it is not generally dangerous, but for three to four miles the gas has a killing power, and precaution should be taken anywhere within that length of the firing line the same as though in the firing line.

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Another nuisance resulting from a gas attack is the wholesale slaughter of rats and other animals that infest the trenches, and while a very unpleasant job, steps should at once be taken to gather these beasts up and bury them in some place, obviously for sanitary reasons.

DUTIES OF A PLATOON COMMANDER AT THE FRONT

General Notes: The selection and training of section commanders is of the highest importance, and a commander must assure himself that the man selected has the confidence of the men as well as his own.

A platoon commander should know his men and all about them, and keep a record in a book arranged in sections always kept up-to-date. This is easy to say, but harder to do, when the platoon changes day by day.

He should know his drill and be capable of moving the platoon into any position easily and by the shortest possible route.

He should know how to organize a task allotted to him, such as delivering over a working party, placing a line of sentries, arranging

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posts and reliefs, and occupying a line of trenches.

He should be able to assume responsibility for all trench stores, bombs, periscopes, etc., handed over to him.

He should know the geography of his battalion trenches, the position of company and battalion headquarters, and keep trained guides at hand who can find their way to all important points by day or night.

GOING INTO THE TRENCHES

Platoons generally enter by not more than two sections at a time, thus minimizing the danger from shell fire and delay at entrance to communication trenches.

Before leaving billets, platoon commanders should explain fully to sergeants and sections commanders the extent of trench to be taken over and the steps to be taken in case they are caught by shelling or rapid fire going up to the trenches. Arrangements should also be made that if casualties occur among the soldiers, relief will proceed as arranged.

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IN THE FIRING LINE

On relieving the fire trenches, the men should make no noise, and rifles must be carried so that they do not show over the parapet. This is necessary even if enemy's trenches are at a distance, as there is always the possibility of a listening or observation post being quite near.

Each man should pair off with one of the party occupying the trench and find out from him any points which may be useful.

A commander should consult the officer or N. C. O. in charge of the outgoing party and obtain the fullest information possible in connection with the position.

Particular points on which information should be obtained from the outgoing officer are generally: (a) behavior of enemy during period preceding relief and any point in their line requiring special information, such as enemy may have cut wire as though preparing to attack; (b) machine gun implacement may be suspected at some particular point; (c) anything ascertained by patrols about ground between firing lines, thus avoiding unnecessary reconnoissance; (d) any standing arrangement for patrols at night, including point at which

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wire can best be passed, ground to be patrolled, or place where they can lie under cover; (e) any parts of trench from which it is not safe to fire. Such positions are apt to occur in winding trenches, and are not always recognizable in the dark; (f) special features of trench, recent improvements, work not completed, dangerous points (on which enemy machine guns are trained at night), useful loopholes for observation; (g) places from which wood and water can be safely obtained; (h) amount of ammunition, number of picks, shovels and empty sandbags in that section of the line.

Information on these points cannot always be given by word of mouth. Written notes and plans should, therefore, be handed over to a platoon commander taking over for the first time.

In the meantime the incoming party should fix bayonets and all go temporarily on sentry at posts taken over. Occasional shots should be fired, so that the enemy's suspicions may not be roused. The outgoing party then starts back, and when clear, the relieving party should be numbered off and sentries posted and dugouts allotted. When practicable sentries should be taken from the dugout closest to his post.

By day the number of sentries varies, but

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should not be less than one in six. The platoon sergeant is responsible for changing sentries, who are generally not on duty more than one hour at a time, unless under exceptional circumstances. When the maximum amount of labor must be obtained from the battalion holding the line, sentry duty is of any length that fits in with working arrangements.

Every man must see that he has a good clear position for all directions. Section commanders must satisfy themselves that men have done this and reported such. When these arrangements are completed, word must be quietly passed down for men not on sentry to stand clear, and they are all not in that position again until the "Stand to" hours, generally the hour nearest dusk and the hour before dawn.

After dark, unless the moon is bright, rifles should be kept in a firing position on the parapet, and all men not on duty should keep rifles with bayonets fixed while in the trench.

Observation. Continuous survey of the enemy's lines through disguised steel loopholes should be made when the trenches are being held for any lengthy period, and such loopholes must always be sideways. Sites may be chosen by day, and made and disguised by night. Two steel loopholes about 3 yards apart

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enable a man with leveled rifle to wait by one while another with field glasses watches for target through the other.

An observer watching persistently through glasses in complete security should make himself so familiar with the look of the opposite trenches as to enable him to observe any alteration in the enemy's wire entanglements, or notice immediately if a new sap has been run out from the enemy trenches under cover of night. He should watch points suspected of being machine gun implacements, and especially at night when the flashes can be detected. Observers should be told what marks, etc., to look for on men exposing themselves, and any result of these observations at once reported to the officer or N. C. O.

Inspection. A platoon commander should make frequent examination of trenches; at least once daily, go around with platoon sergeant and section commanders and decide on the necessary work to be done. Section commanders are responsible for carrying it out.

Before handing over a trench, a platoon commander should make a rigorous inspection to see that it is as clean as possible and that latrines are left in a satisfactory state. This includes the removal of old tins, paper, scraps

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of food, etc., which should be buried or burned, if possible. Empty cartridges should also always be kept cleared out, as they get imbedded in trench floors and hinder subsequent digging.

SENTRIES

If the enemy is close, sentries should be supplied with a small periscope to fix on sticks or bayonets. Magazines must be kept as full as possible. Sentries are not allowed to look over the parapet by day, but by night they must keep a continuous lookout. Shots should be fired even when no lights are showing, on the chance of catching hostile patrols or working parties. The best time to watch across No Man's Land is exactly the minute that the enemy send up a Very light, as there is little danger of one being seen, the real danger coming when the Very light is coming down behind you. Sentries should not reply to bursts of rapid fire on the right or left, unless they have a definite object to fire at.

Arrangements are usually made for commanders of two or three neighboring platoons to divide the night between 10 P. M. and the time for "Standing to" between them.

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The platoon commander on duty in each watch should patrol the line constantly and satisfy himself that the proper number of sentries are on duty and keeping a sufficient look-out; also that they have good firing positions. In each platoon the sergeant and section commanders keep watch similarly in turns during the night, and are responsible for the relief of sentries. They also visit sentries every hour.

It is a rule which must be strongly enforced, that every sentry must challenge each person passing him, as it has often happened that enemy officers with more daring than common sense and speaking fluent English, have come into the trenches and walked up and down without being molested, which was only made possible by sentries not challenging every one passing his post.

RIFLES

Rifles should be inspected every morning in the trenches by the platoon commander, and at other times during the day by the sergeant or section commander, and it should be impressed on the men that ammunition must be kept clean or the rifles are apt to jam.

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The principal defects of a rifle in the trenches are:

(a) Mud in the bolt, owing to rifle being rested on wet parapet or dropped on wet ground. To remedy this a bolt cover is used, or when not obtainable, an old sock pulled over the bolt action gives the desired result.

(b) Muddy ammunition, resulting in mud in chamber. Remedy: Prohibit placing of ammunition on ground and provide proper boxes for it.

(c) Mud in muzzle resulting from rifles being pushed into the sides of the trench. Remedy: Careful and frequent inspection. Rifle barrels must be freed from mud before firing, or they will be injured.

(d) Sticking of cartridges owing to dirt in chamber and magazine. Remedy: The keeping clean of both.

(e) Rust in the lock and insufficient oiling. Remedy: Bolt and magazine tested daily. Cartridges never to be kept in the chamber.

It is a standard rule that never from the time men enter the trenches until they go out, regardless of what they are doing, does their equipment come off, not even to lie down to sleep. During working periods which take the

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men to the trenches, their equipment and rifles must always be carried with them.

PREPARATORY TO ENTERING TRENCHES

Things to be taken note of before entering:

(a) Check periscopes, wire cutters, field glasses, water carriers, stretchers, field dressings, emergency rations, smoke helmets, rifles, identity discs, sandbags, ammunition.

(b) See that water bottles are filled.

(c) Each officer to have an orderly.

(d) Magazines to be charged and bayonets fixed and unfixed beforehand to insure proper working. When taking over the trenches, the first thing to be done is:

(a) Ascertain position of officers' dugouts.

(b) Arrange telephones.

(c) Check stores, tools, and reserve ammunition, and its position.

(d) Obtain rough sketch of front and number of traverses to be manned.

(e) See that entanglements in front of trenches are absolutely intact.

(f) Arrange for water and ration parties and find out position of latrines.

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TAKING OVER TRENCHES

On arrival each sentry is to have a periscope, the whole company to stand at arms, and each platoon to have its own ammunition reserve and all men know where this is. It is of the greatest importance that every detail and portion of trench taken over be known, and also the adjoining trenches as far as they affect the trenches held. Accurate sketches of the trench should be made, and periscopes, prismatic compasses and ruled notebooks are required. General scale is roughly ¼ inch to 10 yards. Drains must be watched and every effort made to keep trenches dry. When large trench mortar batteries of the enemy are active, men must be told off to watch for these bombs, as they are easily seen, and many casualties may be prevented by timely warning of their coming.

The fire trenches should contain as few men as possible, and work should be done at night, the men resting by day.

SNIPING

Each company generally has specially selected men told off as snipers. Strict discipline

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is necessary. They are generally on duty by day and excused from night work, and it is the rule that they are either told off to a definite post or given what is known as a roving commission. These men must be expert in building loopholes of all kinds by day or night, use of telescopic sights, periscopes, etc., the selection and judging of good sniping positions, either for use in front or behind fire trenches; expert in judging distances, in aiming and trigger pressing, in laying fixed rifles for night firing, and in the fixing and laying of rifle batteries.

PATROLS

Patrolling both day and night is of great importance, and generally during the night each unit holding a front line sends out several small patrols which frequently obtain information of great value and at the same time counter the enemy's efforts in this direction.

These patrols generally consist of an officer and four to six men, according to the job in view. Sometimes on highly important work, it is three officers and sufficient orderlies to carry any valuable information obtained quickly back to a pre-arranged headquarters.

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Bombs, revolvers and trench daggers are the only weapons of any value on these patrols. They frequently carry out small operations, such as raiding parties, cutting out parties, etc., obtaining from prisoners taken in this way information as to what enemy troops are opposing them in the line.

When a patrol is out every man in the section of firing line concerned must be warned, as well as the listening posts, and this cannot be done too carefully. It is not a sufficient warning to tell the sentry on duty at the time a patrol goes out, as men cannot all be trusted to pass on instructions, and generally word is quietly passed down the line by an N. C. O. or officer in person, and never passed from man to man. At the same time care must be taken to see that all firing does not cease, as this is undesirable, obviously arousing the enemy's suspicions that something is going on. When these patrols have to lie out in trying conditions during winter months, special dugouts should be kept ready for them on their return.

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DUTIES OF AN OFFICER

Some of the questions an officer should ask himself on taking over a trench and keep in mind during his stay there, are:

1. I am here for two purposes—to do as much damage as possible to the enemy and to hold my part of the line at all costs. Am I doing everything possible to insure my being able to do this?

2. Do I worry the enemy as much as I might, and are the periscope rifles, rifle grenades, catapults and patrols at my disposal organized in the best way to effect this purpose?

3. Am I doing all I can to make my part of the line as strong as possible?

4. Should the enemy succeed in getting into any part of my line, will I be able to at once bring up a section of bombers for immediate counter-attack?

5. Do I connect properly with units on my right and left? Do I know the position of the nearest support, and the position of all machine guns in my vicinity, as well as their lines of fire?

6. Does every man know his firing position,

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and can he fire from it over the parapet at the foot of our wire?

7. Do I do my best to prevent men exposing themselves needlessly? Have I ascertained and warned all my men of the places in my part of the line, including communication trenches, which are exposed to the fire of hostile snipers?

8. Are my sentries in the right places? Are they properly posted by N. C. O.'s and have they received proper instructions? Are the sentries visited at frequent intervals?

9. Have I always got a man ready to take messages to company headquarters? Do I realize that I should at once report any information I may obtain about the enemy, and that such information may be of the greatest use to the highest commanders?

10. Do all my men know their duties in case of attack, especially the bombers? If the enemy succeeds in working into my line at any point, how can I best arrange for counter-attacking him?

11. Are there any suitable places in my part of the line which snipers can use? Have I pointed out to section commanders the portions of the enemy's trench which each one is responsible for keeping under fire, and where the enemy's loopholes are?

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12. Do I thoroughly understand the best method of relief and bringing up of ration and water supplies, and do my men come up into the trenches in absolute silence?

13. Do my men know their way about the trenches in various routes to company and battalion headquarters?

14. Am I acquainted with the arrangements for access to the artillery and for asking, if necessary, for their immediate support? Do I know the location of the nearest telephone?

15. Am I doing my best to collect information about the enemy, his defenses, his activities and movements, and especially about his patrols at night? What points in my front particularly require patrolling?

16. Are my listening patrols properly detailed?

17. Which is my best way to get through the parapet in order to go towards the enemy?

18. Do I know the last order regarding the use of S. O. S., gas and Zeppelin messages, and do I know exactly what messages to send?

19. Are the arrangements in case of gas attack complete and known to all ranks? Do I know the gong position, and does the sentry know the orders as to sounding it?

20. Have my men always got their gas hel-

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mets on their person and are they in good order?

21. Are my parapets and traverses bullet-proof everywhere?

22. Is my wire strong enough and am I doing all I can to prevent my trenches from falling in?

23. Am I doing all I can to drain my trenches?

24. Have my men got weather-proof places to sleep in?

25. Are the trenches as clean and sanitary as they might be? Are live ammunition and empty shells properly collected? Have I made all possible arrangements for the collection of refuse and do the men realize that it must not be thrown over the parapets or in the sump-pits for sanitary reasons?

26. Where are my small ammunition and bomb stores, and are they under cover from weather?

27. Are all my rifles and ammunition clean and in good order, and have all my men rifle covers? Are their magazines always charged?

28. Am I doing all I can to prevent my men from getting trench feet? Have my men greased their feet before entering the trenches, and have they a pair of spare dry socks to

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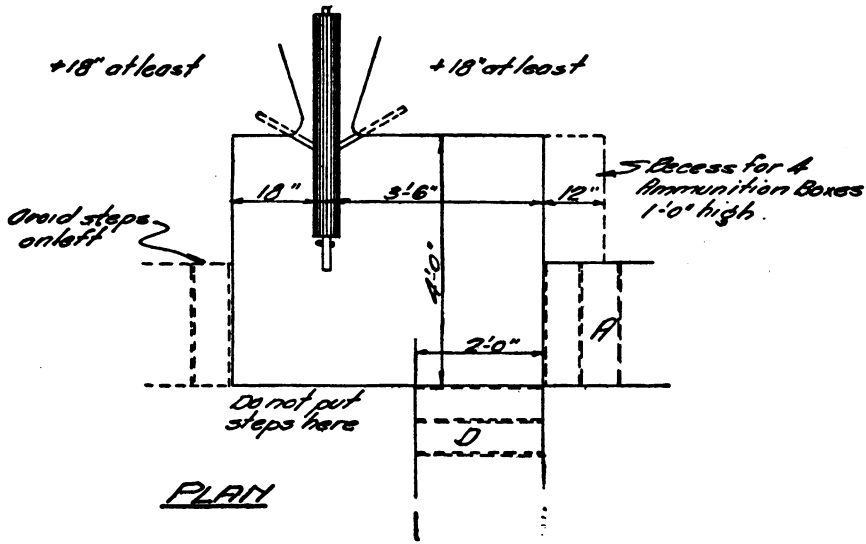

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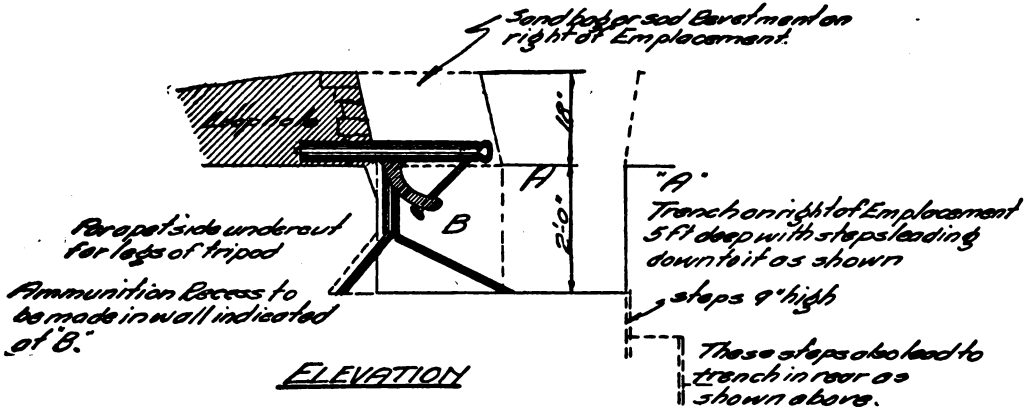

MACHINE GUN EMPLACEMENT

A type of front line emplacement with which an infantry officer should be familiar, but which are constructed by and are entirely under the control of Machine Gun Companies.

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change? Do my men wear gum boots when it is not necessary? Have I made all possible arrangements for drying socks?

29. Are the orders as to wearing equipment carried out?

30. Are my men using as firewood notice boards or wood from the defense or from the engineer or trench stores?

31. Are my men drinking water from any but authorized sources?

32. Do I know the name of every N. C. O. and man in my platoon, and do they know mine?

33. Do I insure that my men get sufficient sleep?

34. Have I sufficient periscopes and are they in good order?

35. Almost always remember that I am here for two purposes. Do as much damage to the enemy with the minimum amount of casualties resulting from retaliation, and to hold my part of the line at all costs.

HOW TO FIRE A MACHINE GUN IN CASE OF EMERGENCY

As a machine gun textbook is very dry, and it is difficult for a man who is not of a mechani-

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cal turn of mind to obtain the most elementary knowledge of the action from a book, officers should lose no time in getting in touch with a machine gun officer and learn from actual experience, how to load, fire and rectify simple stoppage.

LEWIS GUN. To load, put a full magazine on the magazine post with the cocking handle forward.

Pull back cocking handle to its fullest extent, and raise tangent sight unless the target is within 200 yards.

To fire, press the trigger and the gun will continue to fire as long as pressure on the trigger is maintained. It will only stop when (a) the magazine is emptied; (b) stoppage is set up. To remedy this (1) take off empty magazine and put on full one, reload relay and fire; (2) cocking handle stops in one of three positions. To remedy this one must have a thorough knowledge of remedying of stoppages.

VICKER'S AUTOMATIC. To load, pass the brass tack of belt through feed plug (right to left), pull back crank handle and pull belt to the left; release handle and belt; repeat this process and the gun is loaded. Vertical adjustment for sighting is obtained by moving elevating wheel on quadrant of tripod, horizontal adjustment

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by tapping the rear cross-piece. The clamping handle is in front of the cross-band of the tripod. To fire, raise safety catch with first or second finger (the safety catch is a strip of steel which is under the thumb-piece or double button) and press the thumb-piece. The gun will now fire until pressure is released or until a stoppage occurs.

STOPPAGES. There are four common stoppages, distinguished by the position of the crank handle. Remedy: (1) Pull crank handle back and belt to the left, let go crank handle; (2) open rear cover, take out lock, remove bent cartridge from face of lock; (3) hit crank handle down. If it will not go, lift it a little, pull belt and hit again; (4) raise crank handle, pull belt, let go of crank. If not effective, then put in the spare lock, but unload first. To disable gun, remove lock and fuse from fire belt through the breech casing.

PREVENTION OF FROST BITE AND TRENCH FEET

These conditions are generally caused by long standing in cold water and mud, or the continuous wearing of wet socks, boots and put-

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tees, and the conditions are accelerated when the blood circulation in the feet and legs is interfered with by the use of tight puttees, or anything calculated to cause constriction of the lower limbs. They can be prevented or diminished by constant improvement of trenches and reducing the time spent in the trenches as far as the general situation will permit by battalion arrangements; by insuring that men entering the trenches are warmly clad in dry boots, socks, trousers and puttees, and that before entering, the men's legs and feet are thoroughly rubbed with whale oil. Provisions are made for the men on coming out of the trenches to get warm shelters, hot foods and facilities for washing the feet and drying wet clothes, and all along the line just behind the trenches soup kitchens are kept where the men may stop on the way to billet and get hot soup, etc.

The arrangements made when a battalion is going into the trenches are roughly as follows:

The men's feet and legs are washed and dried and then thoroughly rubbed with whale oil and dry socks put on. A second pair of dry socks is carried by each man, and when it is possible, battalion arrangements are made for wet socks to be brought down from the trenches one night and dry ones exchanged, this taking place every

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night. This is generally managed by the men changing in the early morning, the relief party for that night taking down the wet socks and bringing in the dry for the next morning.

Hot water must never be used, nor the feet held near a fire. Where necessary, and circumstances permit, long gum boots are put on on entering the trench, while the men's feet are still dry, and taken off as soon as they prepare to leave and handed over as trench stores.

In some parts of the line, where conditions are very favorable, battalion rest posts are formed as close to the firing line as permissible, and men showing signs of suffering from exposure are frequently attended to.

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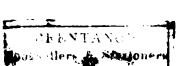

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